

# FLAGLER COUNTY, FLORIDA

## HURRICANE AND STORM DAMAGE REDUCTION PROJECT FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT



September 2014



**US Army Corps  
of Engineers**®  
Jacksonville District

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**HOW TO USE THIS DOCUMENT:** The format of an Environmental Assessment (EA) has been integrated into this Feasibility Report. The basic table of contents below outlines how the EA format has been integrated into the planning process to develop a recommended plan that meets the requirements of both U.S. Army Corps of Engineers Plan Formulation Policy and the National Environmental Policy Act (NEPA). More detailed tables of contents are provided by chapter.

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FLAGLER COUNTY, FLORIDA  
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FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

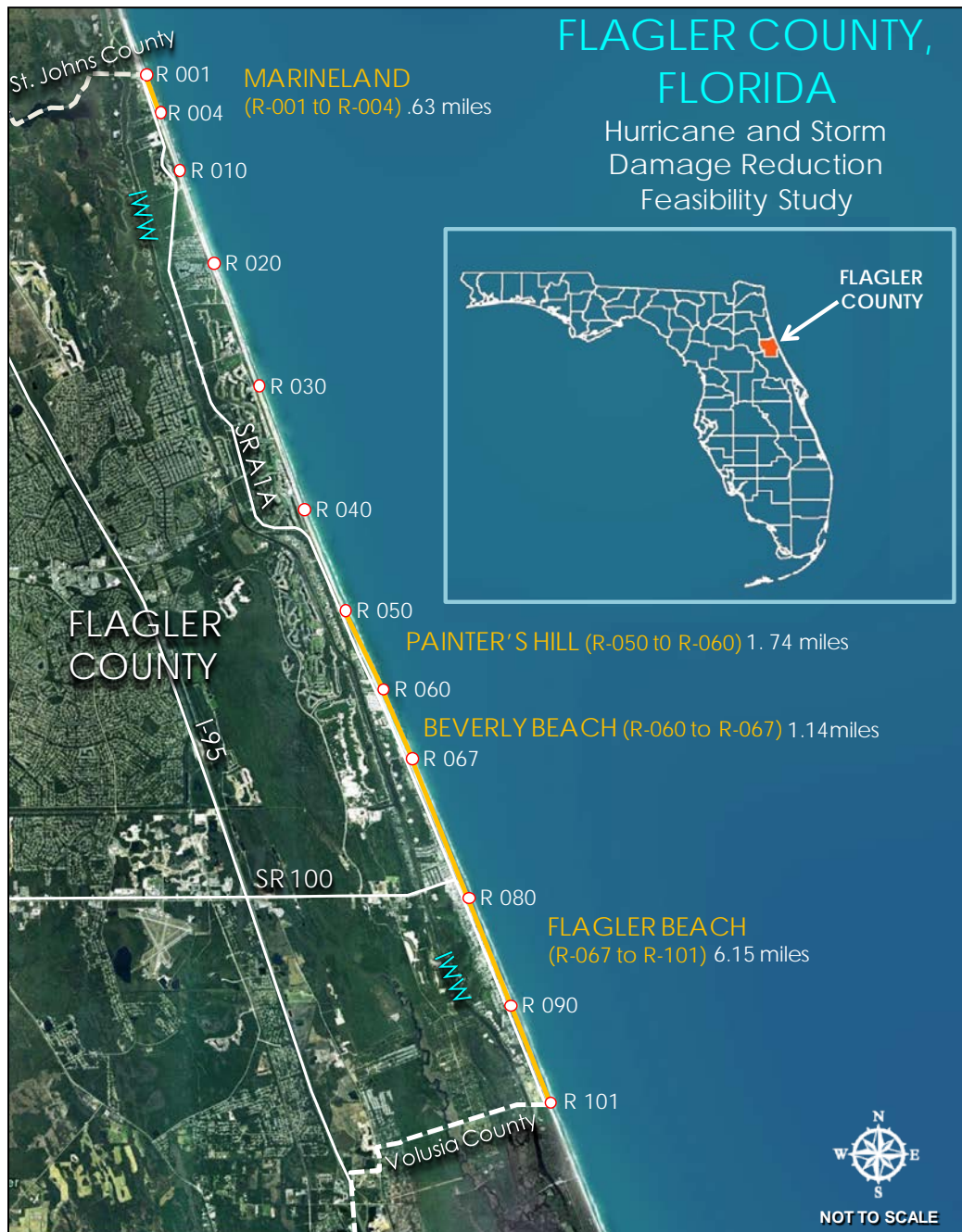
**EXECUTIVE SUMMARY**



## EXECUTIVE SUMMARY

### INTRODUCTION

Flagler County is located on the northeast coast of Florida approximately midway between the Florida/Georgia state line and Cape Canaveral. The county is bounded to the north by St. Johns County and to the south by Volusia County. Flagler County has approximately 18 miles of sandy shoreline, all of which are authorized for Federal study. See **Figure 1**.



**Figure 1: Flagler County Vicinity Map and Study Reaches (Yellow Lines)**

The authority for conducting this Feasibility Study is contained in House Resolution 2676 adopted May 22, 2002:

“Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that in accordance with Section 110 of the Rivers and Harbors Act of 1962, the Secretary of the Army is requested to review the feasibility of providing shoreline erosion protection, hurricane and storm damage reduction, and related purposes to the shores of Flagler County, Florida.”

In response to this authority, the reconnaissance phase of the study was initiated upon receipt of Federal funds in 2003. The reconnaissance study for Flagler County, Florida, completed in March 2004, recommended that this study continue into the feasibility phase based on the likelihood that a Federal project may be justified and implementable given available information.

### **PURPOSE AND NEED**

The Flagler County shoreline is subject to erosion caused by storms and natural shoreline processes. The purpose of this study is to assess the feasibility of providing Federal Hurricane and Storm Damage Reduction (HSDR) measures to portions of the Flagler County shoreline. Shoreline erosion in the Flagler County study reaches threatens oceanfront infrastructure, including National Scenic Highway, State Road (SR) A1A, and over 1,476 structures having a combined estimated structural and content value of approximately \$340 million. SR A1A, the only north-south hurricane evacuation route for communities along this portion of the coastline, is an integral part of the county’s infrastructure and is essential for public safety during evacuation events. Opportunities to reduce the risk of coastal damages and improve conditions were examined in this study. The local sponsor for this project, Flagler County, has indicated strong support for feasibility phase studies for HSDR purposes along their shoreline and has declared willingness and the capability to share applicable costs in the current study and the Recommended Plan.

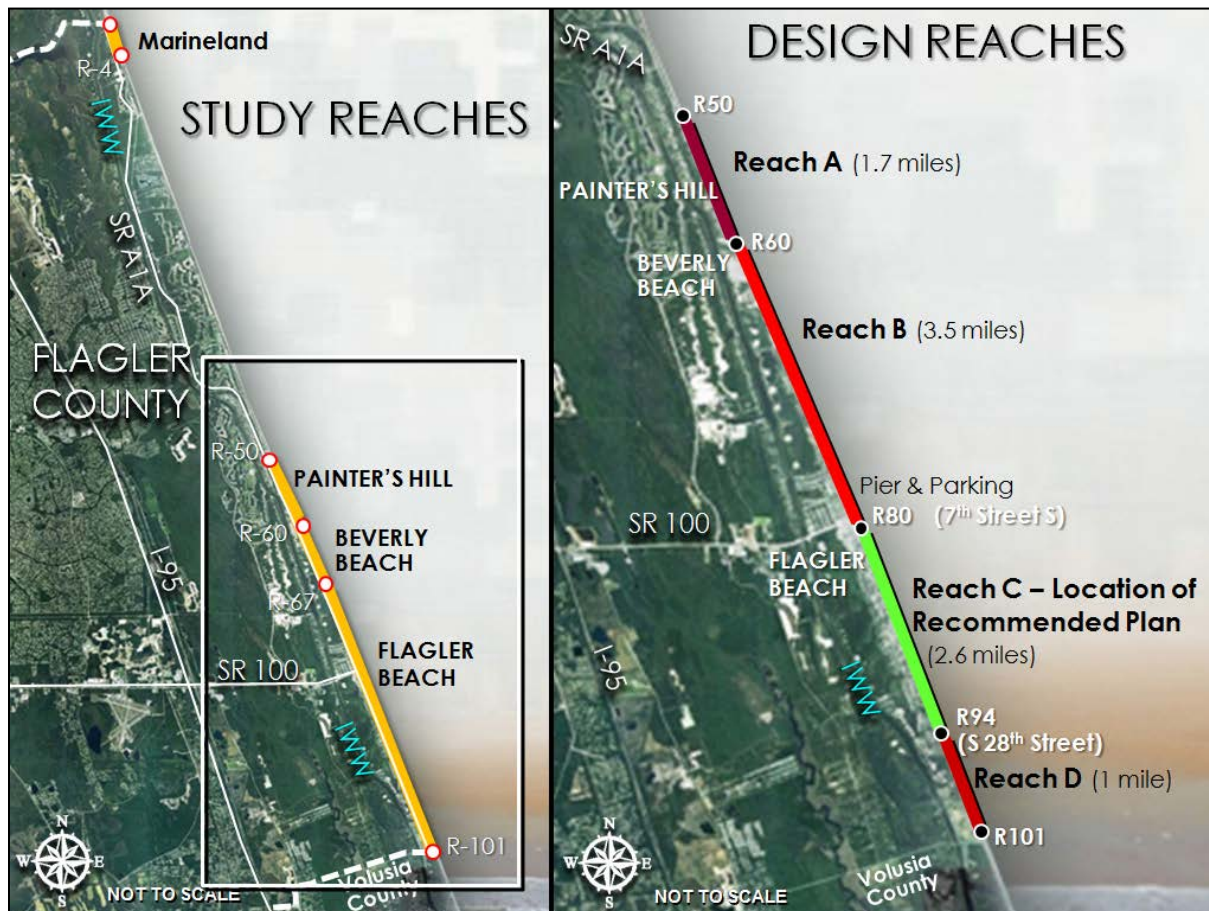
The four study reaches shown in **Figure 1** encompass approximately 9.7 miles of coastline investigated in the Flagler County Feasibility Study. Other areas of the county did not have excessive erosion such that infrastructure was threatened, or potential benefits likely to outweigh the costs of implementing a solution.

### **ALTERNATIVE PLANS AND THE RECOMMENDED PLAN**

This study evaluated the feasibility of providing hurricane and storm damage reduction within the Marineland, Painters Hill, Beverly Beach, and Flagler Beach reaches of the Flagler County coastline. Alternatives considered included: no action, non-structural measures (flood proofing, relocation, land acquisition, etc.), shore protection with hard structures (seawalls, revetments, groins, etc.), shore protection with soft structures (beach nourishment, geotubes, etc.), combinations of the above, and others.

After a preliminary screening of measures based on the potential for meeting the study objectives, followed by a detailed evaluation of a final array of alternatives, the project delivery team identified a Recommended Plan for reducing coastal storm and erosion damage to structures and infrastructure.

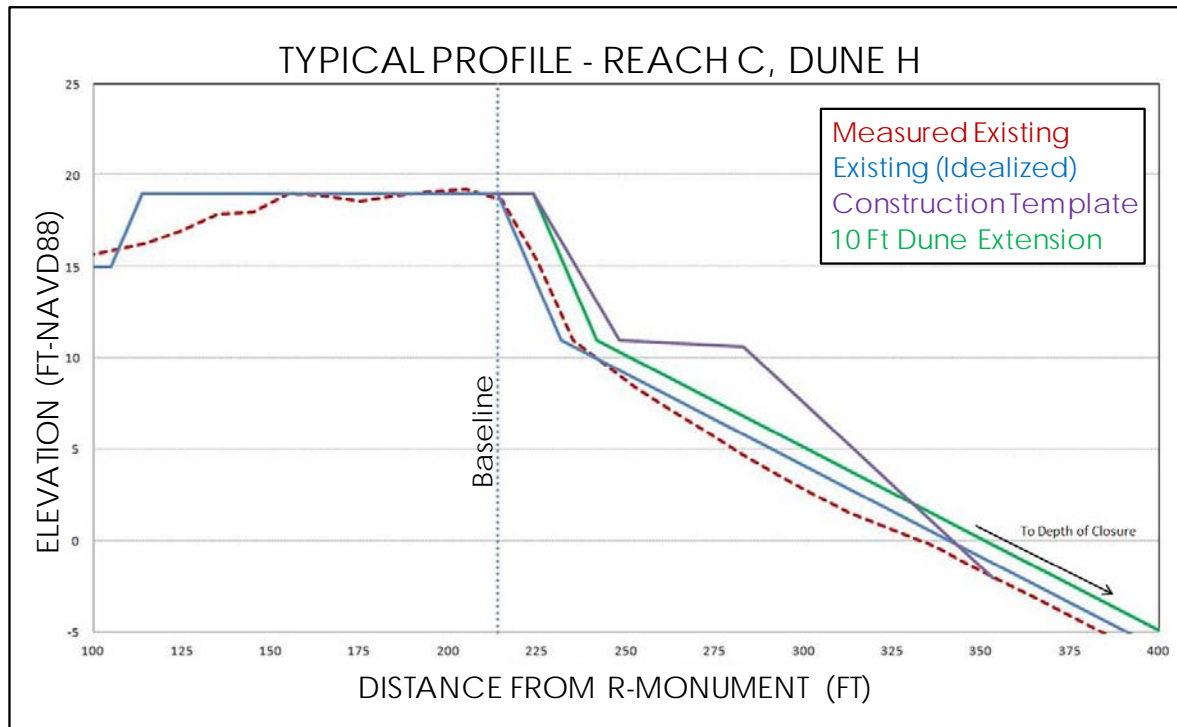
The Recommended Plan is the National Economic Development (NED) plan, consisting of a 10-foot dune and beach profile extension in Reach C, between Florida Department of Environmental Protection (FDEP) monuments R80 and R94 in central Flagler Beach. The Recommended Plan shown in **Figures 2 & 3** covers 2.6 miles of shoreline in length and mainly prevents damage to SR-A1A. **Table 1** provides a summary of the Recommended Plan cost.



**Figure 2: Location of the Recommended Plan (Green Line)**

Construction of the Recommended Plan involves a sand borrow source located seven miles offshore of the project site in Federal waters. The Bureau of Ocean Energy Management (BOEM) has sole jurisdiction over the identified sand resources for this project under the Outer Continental Shelf Lands Act, and is a cooperating agency on this project. The plan will most likely be constructed with a dredge and land-based equipment typically used for beach nourishment projects. Initial construction will require approximately 415,800 cubic yards of sand from the borrow

area (330,000 cubic yards for placement), and each periodic nourishment event will require approximately 403,000 cubic yards from the borrow area (320,000 cubic yards for placement). The renourishment interval is expected to be approximately 11 years, equaling 4 renourishment events in addition to initial construction over the 50-year period of Federal participation.



**Figure 3: Recommended Plan Typical Cross Section**

### **ENVIRONMENTAL CONSIDERATIONS**

Although hardbottom exists along the coast of northern Flagler County in the form of exposed coquina outcroppings, no hardbottom exists in the planned sand placement area or offshore borrow area as verified by environmental resource surveys conducted in 2012. Based on the beach and nearshore hardbottom surveys neither direct burial of coquina outcroppings, nor indirect burial of nearshore hard bottom features through along shore and cross shore transport processes, will occur. No mitigation is required. The appropriate cultural resource studies have been conducted for feasibility stage of this project. There are no recorded cultural resources in the placement or borrow area. Existing dune vegetation will be impacted during construction; however, the Recommended Plan includes planting of dune vegetation on newly constructed areas, as well as revegetation of areas disturbed during construction.



## **COST ESTIMATE AND IMPLEMENTATION**

Total project first costs and cost share breakdown in FY15 price levels are tabulated in **Table 1**. The Project First Costs are \$44,962,000 over 50 years. Initial construction will be cost shared at 65% Federal and 35% non-federal. Periodic nourishments will be cost shared at 50% Federal and 50% non-Federal. The cost of the final periodic renourishment is slightly less than the first 3 periodic renourishments only because less post-construction monitoring is required for the final event. The Federal share of the total project cost is \$24,608,300 and the non-federal share is \$20,353,700.

**Table 1: Cost Summary and Cost Sharing (Project First Costs)**

Flagler County, Florida Hurricane and Storm Damage Reduction Project					
Summary of Project Cost Sharing (Constant Dollar Basis, FY15 (1 Oct 14) price levels)					
Initial Construction					
Cost Share Description	Federal Cost Share %	Federal Cost	Non-Federal Cost Share %	Non-Federal Cost	Project First Cost
Storm Damage Reduction Costs	65%	\$9,218,300	35%	\$4,963,700	\$14,182,000
Real Estate Costs (LERRD Credit)	0%	\$0	100%	\$3,336,000	\$3,336,000
Cash Portion		\$9,218,300		\$1,627,700	\$10,846,000
Periodic Nourishment					
Periodic Nourishment	50%	\$15,390,000	50%	\$15,390,000	\$30,780,000
Initial Construction + Periodic Nourishment					
Final Project Cost Share and Cost (50 years)	55%	\$24,608,300	45%	\$20,353,700	\$44,962,000

LERRD – Lands, Easements, Rights-of-Way, Relocations, Disposal

The average annual costs and benefits, shown in **Table 2**, of the recommend plan in FY14 price levels and 3.50% discount rate are \$1,239,000 and \$2,362,000 respectively. The average annual net benefits for the recommended plan are \$1,123,000 and benefit cost ratio (BCR) is 1.9 to 1.

**Table 2: Economic Summary**

<b>Economic Summary (FY 14 Price Level, 50 -Year Period of Analysis, 3.5% Discount Rate)</b>	
Initial Construction	\$14,114,220
1st Renourishment	\$7,589,733
2nd Renourishment	\$7,589,733
3rd Renourishment	\$7,589,733
4th Renourishment	\$7,503,633
<b>Total First Cost</b>	<b>\$44,387,052</b>
Interest During Construction (IDC)	\$163,000
<b>Total Investment Cost</b>	<b>\$44,550,052</b>
Average Annual Investment Cost	\$1,229,000
Annual OMRR&R (100% Non-Federal)	\$10,000
<b>Total Average Annual Cost</b>	<b>\$1,239,000</b>
Average Annual Storm Damage Reduction	\$2,159,000
Average Annual Recreation Benefits	\$72,000
Average Annual Traffic Reroute Benefits	\$131,000
<b>Average Annual Total Benefits</b>	<b>\$2,362,000</b>
<b>Average Annual Net Benefits</b>	<b>\$1,123,000</b>
<b>Benefit Cost Ratio (3.5 % discount rate)</b>	<b>1.9</b>

## **COORDINATION WITH AGENCIES AND THE PUBLIC**

To ensure that the public and Federal, tribal, state, and local agencies were kept informed about progress on technical analyses and policy issues, public meetings were held throughout the study period. A scoping letter was mailed to all Federal, state, and local agencies; local libraries; and all abutting property owners on 26 August 2008. A public scoping meeting was held in Bunnell, Flagler County, Florida on 25 October 2011 in fulfillment of NEPA requirements at which a diversity of views were presented including those for and against a coastal storm damage reduction project. Notification of the Draft Integrated Feasibility Study and Environmental Assessment for public review and comment was issued on 17 January 2014. A public workshop on the Draft Integrated Feasibility Study and Environmental Assessment was held in Bunnell, Florida on 5 February 2014. Comments and questions on the Draft Integrated Feasibility Study and Environmental Assessment from resource agencies were received from 17 January 2014 through 15 March 2014. The Bureau of Ocean Energy Management (BOEM) was the only Federal agency to submit comments. Comments were received from state agencies including the Florida Fish and Wildlife Conservation Commission (FWC), the Florida Department of Environmental Protection (FDEP), and the Florida Department of Transportation (FDOT).

There is support for the project goals and objectives. There are no major controversial issues associated with this project. In addition to being economically justified based on National Economic Development (NED) benefits, the recommended plan will also yield incidental benefits under the Environmental Quality (EQ) and Other Social Effects (OSE) accounts. EQ benefits include the establishment of vegetated dune system that will promote biodiversity and establish at least 3.15 acres of suitable nesting habitat. OSE benefits include reduced damages and closures of the hurricane evacuation route which will improve the community's resilience following storms.

## **RESIDUAL RISK**

The proposed project would greatly reduce, but not completely eliminate future storm damages. Coastal storm damages are reduced by approximately 96% in the location of the recommended plan (design reach C) over the 50 year period of analysis; therefore, the residual damages would be 4% in this area. Across all four design reaches evaluated (design reaches A, B, C, and D), the recommended plan reduces approximately 65% of coastal storm damages over the 50 year period of analysis; therefore the residual damages across the four design reaches is 35%. The greatest residual risk remains in design reach A, where justifiable improvements could be made if public access was made available. The majority of these damages are associated with the economic cost of older houses (built prior to 1988) constructing vinyl sheet pile walls to protect residences. The FWOP damages in design reach A do not include damages to SR A1A which is located landward of the residences in this reach. The residual risk that remains in design reaches B and D consists of minor armor costs and road damage to SR A1A which is not great enough to justify a project.

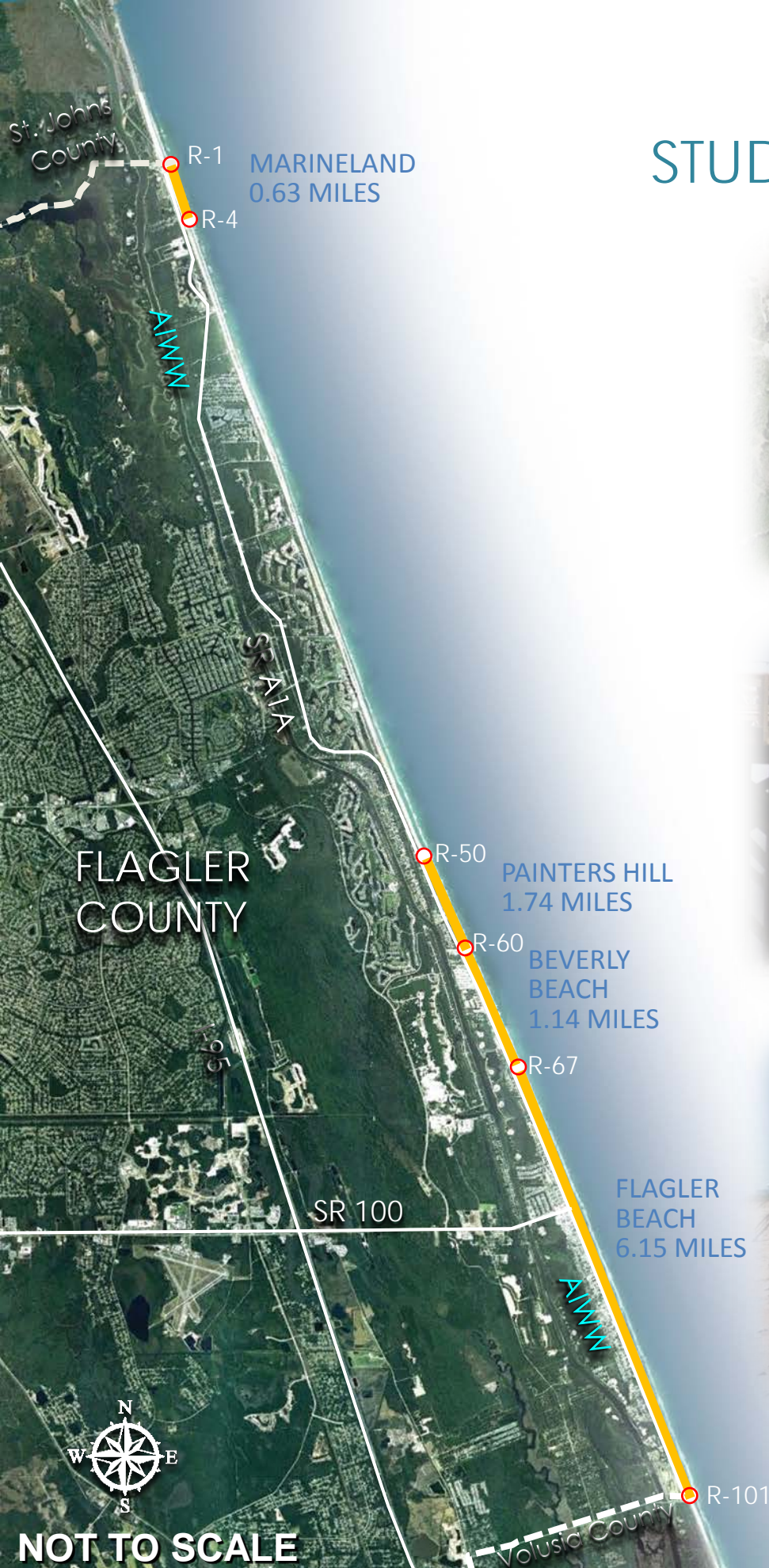
The proposed dune and beach profile extension would reduce damages but does not have a specific design level. In other words, the project is not designed to fully withstand a certain category of hurricane or a certain frequency storm event. The project is not claiming any benefits beyond 400 feet inland from the Mean High Water (MHW) line, damages to structures past this extent were not calculated. Structures would also continue to be subject to damage from hurricane winds and windblown debris. Even new construction is not immune to damage, especially from these processes. The project purpose is storm damage reduction, and the dune and profile extension is not designed to prevent loss of life. Public safety risks can be reduced by actions taken at the local, state, and Federal levels. **Table 3** describes the actions that can be taken by the entities associated with this project to improve public safety, as well as the limitations of their actions. The greatest level of public safety is achieved when action is taken at the local, state, and Federal Level to reduce public safety risks in a comprehensive manner.

**Table 3: Roles for Public Safety**

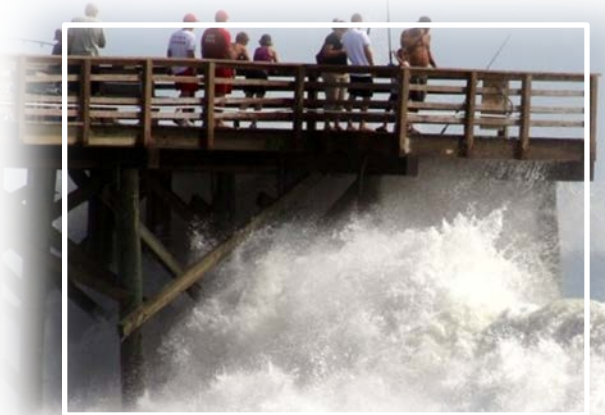
	<b>Can Do</b>	<b>Can't Do</b>
<b>Flagler County</b>	<ul style="list-style-type: none"> <li>Can implement non-structural risk reduction efforts including building and zoning regulations.</li> <li>Can implement emergency management plans and strategies.</li> <li>Can sponsor and cost share in a Federal dune and beach project.</li> </ul>	<ul style="list-style-type: none"> <li>Can't afford a dune and beach nourishment project on their own.</li> </ul>
<b>State of Florida</b>	<ul style="list-style-type: none"> <li>Can implement non-structural risk reduction efforts including building and zoning regulations.</li> <li>Can implement emergency management plans and strategies</li> <li>Can perform maintenance of SR A1A and repair on an emergency basis by dumping rocks.</li> </ul>	<ul style="list-style-type: none"> <li>Can't construct seaward of the FDOT right of way.</li> <li>Can't abandon or relocate SR A1A.</li> </ul>
<b>US Army Corps of Engineers</b>	<ul style="list-style-type: none"> <li>Can implement a cost shared dune and beach nourishment project that reduces damages SR A1A and provides additional protection of the evacuation route beyond what the county and state are capable of providing.</li> </ul>	<ul style="list-style-type: none"> <li>Can't enforce building and zoning regulations.</li> <li>Can't implement local emergency management plans and strategies.</li> </ul>

# CHAPTER 1

## STUDY INFORMATION



Marineland



Flagler Beach Pier



Flagler Beach

FLAGLER COUNTY, FLORIDA  
HURRICANE AND STORM DAMAGE REDUCTION PROJECT  
FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

**CHAPTER 1**  
**STUDY INFORMATION**

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## 1 STUDY INFORMATION

### 1.1 Introduction \*

Flagler County is located on the northeast coast of Florida approximately midway between the Florida/Georgia state line and Cape Canaveral to the south (refer to **Figure 1-1**). The county is bounded to the north by St. Johns County and to the south by Volusia County. Flagler County has approximately 18 miles of sandy shoreline, all of which are authorized for Federal study. The coast has no inlets or embayments and the beaches are typically fronted by steep dune faces or rock revetment. Sections of coquina rock outcroppings and nearshore hardbottom are present along the coast. The Flagler County shoreline is subject to erosion caused by both storms and natural shoreline processes. The purpose of this study is to assess the feasibility of providing Federal Hurricane and Storm Damage Reduction (HSDR) measures to portions of the Flagler County shoreline. The local sponsor for this project is Flagler County.

In 2009, the Florida Department of Environmental Protection (FDEP) had designated six coastal reaches as critically eroded. Both qualitative assessments and quantitative data and analyses are used to recommend a segment of shoreline as critically eroded. For an erosion problem area to be designated as critical, there must be a threat to, or loss of, one of four specific interests – upland development, recreation, wildlife habitat, or important cultural resources (FDEP, 2008). The reaches listed in **Table 1-1** received the critical designation as a result of erosion threatening development and State Road A1A (SR A1A). FDEP reference (R) monuments are located approximately every 1,000 feet along the shoreline and serve as geographic reference points for survey profile lines.

**Table 1- 1: FDEP designated critically eroded reaches (June 2009), Flagler County**

LOCATION	LOCATION (FDEP R monument)	EXTENT (miles)
Marineland	1 - 4	0.6
Painters Hill*	52.3 - 53.4	0.1
Painters Hill*	55.2 - 57	0.3
Beverly Beach	65.2 - 70	0.9
Flagler Beach	76 - 94.8	3.3
Flagler Beach*	98 -101	0.5
Total		5.7

Through coordination with the project sponsor and FDEP, the Flagler County feasibility study reaches have been developed based on these critically eroded areas, which were recommended for further investigation in the 2004 Reconnaissance Report. At the north end of the county, the Marineland study reach consists of the critically eroded area from the St. Johns County border at R-1 south



to R-4. The Painters Hill, Beverly Beach, and Flagler Beach study reaches span the southern half of the county from R-50 to R-101. The Painters Hill study reach is located in the middle of the county and extends from R-50 to R-60. Directly to the south from R-60 to R67 is the Beverly Beach study reach. The Flagler Beach study reach extends from the Beverly Beach study reach at R-67 all the way down to the Volusia County border at R-101. Study reach areas not designated as critically eroded by the FDEP were also included in the feasibility study area; though erosion in these areas is not currently causing a critical threat to public or private interests, it is possible that as erosion continues these areas will become critically threatened. From 2000 to 2009 the critically eroded areas in the southern 3 study reaches expanded from 2.9 miles to 5.1 miles. By including the entire southern half of the county, economic and real estate data will be available to determine the benefits of reducing the risk of storm damage in the critical areas along with non-critical areas that could likely become critical in the future if no action is taken. Additionally, shore protection alternatives may need to be implemented on a scale that includes the shoreline adjacent to and in between critical areas in order to be functional. The established study reaches will allow for the formulation of a plan that will best address the shoreline erosion problems in Flagler County.

The most recent update to FDEP critically eroded reaches was made in June 2012. As of this update, areas in Painter's Hill (R52.3 to 57) and Flagler Beach (R98 to 101) were no longer considered critically eroded by FDEP (see **Table 1- 2**) due to shoreline accretion (sand buildup and seaward advance of the shoreline).

**Table 1-2: Changes to FDEP designated critically eroded reaches from June 2009 – June 2012, Flagler County**

LOCATION	LOCATION (FDEP R monument)	EXTENT (miles)
Marineland	1 - 4	0.6
<del>Painters Hill</del>	<del>52.3 - 53.4</del>	<del>0.4</del>
<del>Painters Hill</del>	<del>55.2 - 57</del>	<del>0.3</del>
Beverly Beach	65.2 - 70	0.9
Flagler Beach	76 - 94.8	3.3
<del>Flagler Beach</del>	<del>98 - 101</del>	<del>0.5</del>
Total		4.8

The four study reaches listed in Table 1-3 encompass approximately 9.7 miles of coastline to be investigated in the Flagler County Feasibility Study with 4.8 miles of that shoreline currently designated as critically eroded by FDEP. **Figure 1-1** provides a plan view of the project area and study reaches.

Shoreline erosion in the Flagler County study reaches threatens oceanfront infrastructure, including National Scenic Highway SR A1A, and over 1,476 structures having a combined estimated structural and content value of approximately \$340 million. SR A1A, the only north-south hurricane evacuation route for communities along the coastline, is an integral part of the county's infrastructure and is essential for public safety during evacuation events. Opportunities to reduce the risk of coastal damages and improve conditions will be examined in this study.

**Table 1-3: Designated feasibility study reaches for Flagler County, Florida**

NAME	LOCATION (FDEP R monument)	APPROXIMATE EXTENT (miles)
Marineland	1 - 4	0.63
Painters Hill	50-60	1.74
Beverly Beach	60-67	1.14
Flagler Beach	67-101	6.15
Total		9.66

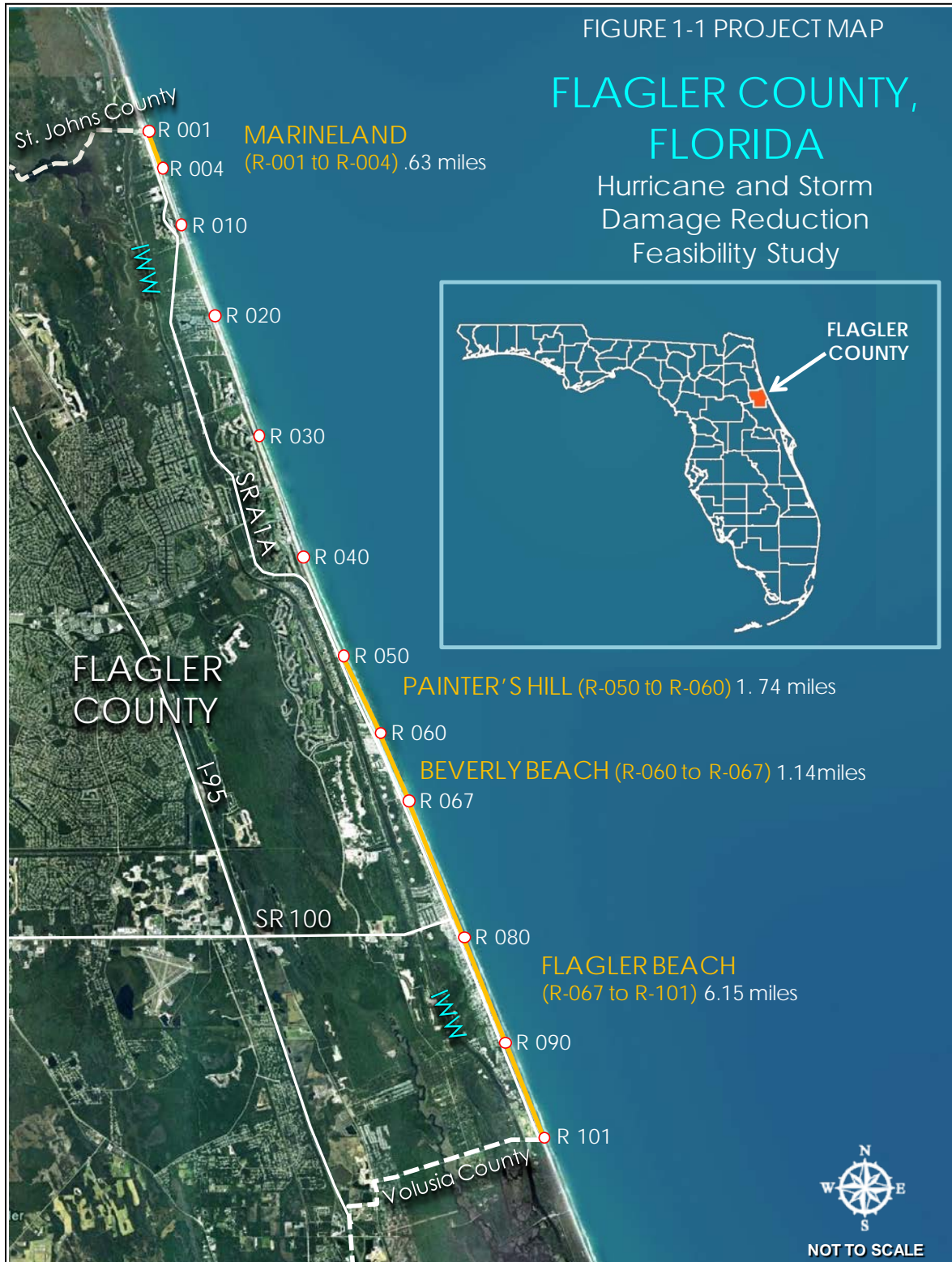


Figure 1- 1: General location map of Flagler County and the study reaches (yellow lines).

## 1.2 Study Authority \*

The authority for conducting this Feasibility Study is contained in House Resolution 2676 adopted May 22, 2002:

“Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that in accordance with Section 110 of the Rivers and Harbors Act of 1962, the Secretary of the Army is requested to review the feasibility of providing shoreline erosion protection, hurricane and storm damage reduction, and related purposes to the shores of Flagler County, Florida.”

In response to this authority, the reconnaissance phase of the study was initiated upon receipt of Federal funds in 2003. The reconnaissance study for Flagler County, Florida, completed in March 2004, recommended that this study continue into the feasibility phase based on the likelihood that a Federal project may be justified and implementable given available information.

## 1.3 Purpose and Scope \*

This study will determine the feasibility of providing hurricane and storm damage reduction within the Marineland, Painters Hill, Beverly Beach, and Flagler Beach reaches of the Flagler County coastline. Alternatives considered will include: no action, non-structural measures (flood proofing, relocation, land acquisition, etc.), shore protection with hard structures (seawalls, revetments, groins, etc.), shore protection with soft structures (beach nourishment, geotubes, etc.), combinations of the above, and others.

This report will recommend a plan that is technically sound, environmentally acceptable, and economically justified. **Appendix A**, Engineering Analysis and Design, will include suitable data to proceed into the preconstruction, engineering, and design (PED) phase of the project, contingent upon funding. Following the PED phase, construction of the recommended plan will be contingent upon congressional authorization, available Federal and non-federal sponsor funds, and will be subject to Department of the Army policy, guidance, and regulations.

## 1.4 Location of the Study Area \*

The Flagler County study area extends from R1 to R4 in Marineland and from R50 to R101 from Painters Hill through Flagler Beach and approximately 400 feet inland from the Mean High Water (MHW) line in each of the study reaches described in **Table 1-2**. The inland extent of the Flagler County study is based on detailed engineering analysis recently completed for St. Johns County, the adjacent county to the north. The St. Johns County, Florida, General Reevaluation Report (USACE, 1998), which recommended beach nourishment along St. Augustine Beach,

determined 300 feet to be the approximate extent of shoreline recession expected from a 100-year storm. A 100-year storm is defined as storm that statistically has a 1-percent chance of occurring in any given year. The extent of shoreline recession in the current study area can be expected to be similar to that immediately to the north since geographic characteristics and wave climate closely resemble those of St. Johns County. The additional 100 feet was added to the probable 100-year storm recession to ensure adequate data collection for probable areas of impact. Figure 1-1 provides a location map of Flagler County.

The study area includes the areas investigated for potential sand sources that could be used to implement storm damage reduction measures. These include upland sand mines and offshore borrow areas. Several of the offshore borrow areas investigated are partially or fully located in Outer Continental Shelf (OCS) waters, which is under the sole jurisdiction of the Bureau of Ocean Energy Management (BOEM) under the Department of Interior.

## 1.5 History of the Investigation \*

### 1.5.1 Erosion Problems

Since its earliest development in the 1920s, the Flagler County coastline has experienced sporadic accelerated beach erosion rates due to hurricanes and northeaster storms. The resultant damages to coastal infrastructure spurred local and state shore protection measures in various areas, particularly along A1A in Flagler Beach. State assistance, in response to catastrophic erosion events, has resulted in the construction of revetments, seawalls and temporary structures, structure condemnation, and various shore protection measures by private property owners. During the months of June through November, Flagler County is particularly at risk of damages from high winds and storm inundation caused by hurricanes and tropical storms. However, winter storms, or northeasters, are thought to have a greater impact on shoreline change than hurricanes in Flagler County because these winter storms occur more frequently and with longer duration of damaging waves and storm surge.

Several notable hurricanes that have affected Flagler County include: Dora (1964); David (1979); Bob (1985); Dennis, Floyd, and Irene (1999); and Frances and Jeanne (2004). During the fall of 2001 Tropical Storm Gabrielle caused significant erosion, prompting FDEP to include some areas of Flagler County, for the first time, as critically eroded beaches (FDEP, 2008). Due to its extended duration, Tropical Storm Fay caused significant erosion along the Flagler County shoreline in August 2008.

Due to their higher frequency and typically longer duration, northeasters most likely have a higher impact on Flagler County beaches than hurricanes and tropical

storms. Severe northeaster storm events impact Flagler County beaches annually. Florida experienced intense northeaster storm events during the years 1984, 1993, and 1994, all of which drastically altered beach profiles statewide. In 2007, Florida's entire Atlantic coast experienced the cumulative effects of several intense northeaster storms which intensified erosion in some areas of Flagler County, prompting FDEP to add a shoreline segment at Painters Hill to the 2008 critically eroded beaches listing. Historically, the threat of storm damage to coastal infrastructure has resulted in coastal armoring throughout several sections of Flagler County.

### 1.5.2 Coastal Armoring

The first coastal armoring effort in Flagler County was constructed along the shorelines of the Town of Marineland at the northern end of Flagler County. Between what are now FDEP monuments R1 and R3, a 1,350-foot long coquina rock revetment and a series of five coquina rock groins extending approximately 250 feet seaward were constructed in 1938. These structures protected the world famous Marineland Oceanarium and Aquatic Park, which was the first of its kind, and is still in operation today. In 2001, the Town of Marineland removed the original coquina revetment and replaced it with a 1,350-foot long revetment constructed of large granite stones, capped with a sheet pile anchored seawall, to protect the town and oceanarium from storm damage. Approximately 1,500 feet of additional seawall extends south of the revetment, covered by reconstructed dunes and a boardwalk. As part of the 2001 rejuvenation, a 1,000-foot long boardwalk and 1,000 linear feet of beach and dunes were constructed above a portion of the seawall cap. Additional public access was also constructed at the southern end of the revetted area.

Another major coastal armoring in Flagler County exists along SR A1A in Flagler Beach. SR A1A has historically experienced, and continues to experience, severe erosion from natural causes. Initial hardening actions along SR A1A, which included sand and coquina rock placement, were constructed as a result of Hurricane Dora impacts in 1964. A revetment permit was issued in 1981 for the placement of additional segments of sand and coquina rock revetment in areas north and south of the Flagler pier. In 1999, granite rock was placed between South 7<sup>th</sup> Street and South 23<sup>rd</sup> Street. The revetment in Flagler Beach has been repaired and restored many times since its initial construction. In 2007 alone, the Florida Department of Transportation (FDOT) performed 15 emergency or temporary repairs to the Flagler Beach segment of SR A1A (USFWS, 2009) at a cost of \$847,000. Between 2000 and 2007, FDOT maintenance costs for SR A1A in Flagler Beach averaged \$1.25 million per year (FDOT, 2010). Currently, the granite revetment protecting SR A1A in Flagler Beach extends from FDEP range monument R80 to R90 with aging and dilapidated segments of coquina rock protection extending north to approximately R76 and south of R90 approximately 150 feet.

## 1.6 Prior Reports and Existing Projects \*

Several previous investigations and reports have been completed for the area by both Federal and non-federal parties. The most recent studies pertinent to Flagler County's coastal erosion are summarized in the following subsections.

### 1.6.1 Prior Federal Studies

Summaries of prior Federal studies relevant to this project are as follows:

*Flagler County, Florida. Beach Erosion Control and Hurricane Protection Reconnaissance Report*, U.S. Army Corps of Engineers, Jacksonville District, August 1980. The report emphasizes continuous erosion and substantial expenditures by both private citizens and local governments for restoration of private and public lands following erosion and storm damage. Economic justification considered future development of the county and a plan of study for developing non-structural alternatives for erosion control and storm protection was recommended. Further Federal study was never approved.

*Section 14 Study, Flagler Beach, Flagler County, Florida*, U.S. Army Corps of Engineers, Jacksonville District, November 1982. Section 14 is a continuing authority for emergency streambank and shore protection. In response to a request for emergency Federal assistance from Flagler County, a Section 14 Study was undertaken to investigate the feasibility of building a stone revetment along state road A1A in Flagler Beach to protect a 2,200 foot long section of the road from being undermined by storm induced erosion. Based on lack of financial support from the non-federal sponsor, no Federal project was adopted.

*Flagler County, Florida Shore Protection Study Reconnaissance Report*, U.S. Army Corps of Engineers, Jacksonville District, May, 1988. This report investigates the practicality of initiating a Federal feasibility study on shoreline protection for Flagler County, Florida. The report looks at the County's entire 18 miles of shoreline, but focuses on the Flagler Beach area. The report concluded that there was no Federal interest in further study for those beaches at that time. The report, which compares the average annual costs and benefits of a storm damage reduction project, found that such a project at the time was not economically justified.

*Reconnaissance Report, Section 905(b) Analysis, Flagler County, Florida, Shore Protection*, U.S. Army Corps of Engineers, Jacksonville District March, 2004. This report represents the most recent effort to assess the needs for hurricane and storm damage protection along the coastline of Flagler County. Following the previous reconnaissance report in 1988, as erosion along the shoreline continued, the population in Flagler County greatly increased as well as the amount of development along the coast. The study concluded that there is strong Federal interest in

initiating a feasibility phase study based on the likelihood that a Federal project may be justified and implementable.

*Project Inspection Report: Flagler County, Florida Federal Shore Protection Project*, U.S. Army Corps of Engineers, Jacksonville District, August 23, 2008. The brief Project Inspection Report summarizes the general conditions of the beaches along the Marineland, Painters Hill, Beverly Beach, and Flagler Beach study reaches. This inspection report documented beach erosion along the Flagler County shoreline which was caused by Tropical Storm Fay. Tropical Storm Fay affected Florida's mid and north Atlantic coasts from August 20-22, 2008.

*Biological Opinion*, United States Fish and Wildlife Service, July 2009. The document provides the USFWS biological opinion of SR A1A Shoreline Stabilization measures proposed by FDOT for Flagler Beach. The report identifies 11 areas along the roadway where erosion problems are recurring or have recently become problematic. Also, an extensive summary of the effects of the proposed shoreline stabilization project on endangered sea turtles that exist in the study area is provided. The report concludes that the erosion control systems proposed for use to stabilize SR A1A are not likely to jeopardize the continued existence of the loggerhead, green, or leatherback sea turtles.

#### 1.6.2 Prior Non-federal Studies

Summaries of prior non-federal studies relevant to the project are as follows:

*Shoreline Change Rate Estimates, Flagler County*, Florida Department of Environmental Protection (FDEP), July, 1999. The report prepared by FDEP provides shoreline change rate estimates to assist in regulatory programs and beach management planning efforts. The report estimated a shoreline change rate of approximately -1 foot per year for the county.

*Strategic Beach Management Plan for Northeast Atlantic Coast Region*, Florida Department of Environmental Protection, October, 2001. The report presents data, analysis, and recommendations for managing the northeast Florida coastline, specifically the Sea Islands, and the beaches and inlets of St. Johns, Flagler, and Volusia counties. Special attention is placed on determining strategies for inlets and critically eroded beaches.

*Revetment at Marineland*, In 2001 the Town of Marineland completed rejuvenation of a seawall and revetment to protect the town and oceanarium from storm damage. The seawall and revetment were a cooperative effort between the Town of Marineland, Federal Emergency Management Agency (FEMA), and the Florida Division of Emergency Management for restoration of damage from Hurricanes Floyd and Irene and mitigation against future storm damage. In addition, the project protects a public park, the River to the Sea Preserve (which includes beach access and parking), and reestablished the beach and dune.



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*State Road A1A Shore Protection Evaluation Flagler Beach, Flagler County, Florida*, Taylor Engineering, Inc., June 2002. The purpose of this study was to determine the most technically feasible and financially acceptable alternatives for protecting “critically eroding” shoreline from R-78 to R-92 in Flagler Beach, which is bordered by the National Scenic Highway, SR A1A. The report concludes with a two-part recommendation for a seawall and/or some form of beach nourishment plan in order to protect Highway A1A. The study was funded in part by the Florida Department of Transportation and Flagler County.

*State Road A1A Shoreline Stabilization Project, Flagler Beach, Florida*, Florida Department of Transportation (FDOT) – District 5, April 2006. The report was completed as a technical memorandum in support of FDOT’s continuous efforts to protect SR A1A from being undermined by erosion. The report provides a review of current and historical conditions, a coastal engineering literature review pertinent to seawall impacts, comments on alternative erosion protection measures for SR A1A, and a discussion of potential environmental and shoreline impacts and optional mitigation measures for several shoreline protection alternatives.

*Flagler County, State Road A1A PD&E Study*, FDOT, January 2010. The Project Development and Environmental (PD&E) Study covers an approximately 5-mile stretch of SR A1A through Flagler and Beverly Beach. The study includes considerations for the possible construction of segments of seawall, revetment, or dune nourishment and impacts, costs, etc. of those options. FDOT does not currently have any dune stabilization plans for SR A1A in their 5-year work program. The main purpose of this PD&E Study was to comply with the National Environmental Policy Act (NEPA) so that work can be done in the future with Federal funds, and to inform the local officials and citizens of Flagler Beach of the various options available to FDOT regarding shoreline protection.

*Critically Eroded Beaches in Florida*, Florida Department of Environmental Protection June, 2008. This report was prepared by FDEP to provide an inventory of Florida’s critically and non-critically eroded shoreline areas. The report designates six critically eroded beach segments (5.7 miles) in Flagler County.

*City of Flagler Beach, Coastal Avulsion Mitigation and Resurrection [sic] Analysis*, Holmberg, 2013. This analysis was prepared by Mr. Holmberg, president of Holmberg Technologies, Inc. for the City of Flagler Beach. The analysis includes Mr. Holmberg’s evaluation of erosion issues in the study area and recommends installation of the “Holmberg System” (undercurrent stabilizers).

### 1.6.3 Adjacent Projects

*Florida Intracoastal Waterway*, The Florida Intracoastal Waterway (IWW) is part of the intracoastal waterway system that provides an inland navigation channel from New York to Miami. By 1965 the United States had completed the project from Jacksonville to Fort Pierce, Florida, to the authorized depth of 12 feet and the project

width of 125 feet. The IWW in Flagler County extends from River Mile 55.71 through 73.85. The Florida Inland Navigation District (FIND) provides the items of local cooperation for the waterway and performs maintenance in the absence of Federal funding. The principal items of local cooperation are lands, easements, rights-of-way, and dredged material disposal areas. No dredged material disposal areas exist in Flagler County.

*The Intracoastal Waterway near Matanzas Inlet*, The section of the Intracoastal Waterway, to the north of Flagler County, is subject to shoaling and must regularly be dredged to maintain inland navigation. Maintenance dredging of the IWW channel in the vicinity of Matanzas Inlet removes between 150,000 and 200,000 cubic yards per year of dredged material (personal communication FIND, 2003). The material is pumped into dredged material management site MSA SJ-1 until its 800,000 cubic yard capacity is reached. In 1999 approximately 765,000 cubic yards were pumped from MSA SJ-1 and the IWW onto the beach at Summer Haven, directly adjacent to the northern border of Flagler County. This fine grained sand placed at Summer Haven beach, approximately 2.5 miles north of Marineland, tends to migrate rapidly after placement (FDEP, 2000), possibly reaching the beaches of the Marineland study reach. Table 1- 4 summarizes the IWW maintenance dredging beach placement activities in St. Johns County from 1992 to present.

**Table 1- 4: Intracoastal Waterway Maintenance Dredging Beach Placement in St. Johns County 1992-present**

Location	Year	Placement Area	Volume (cy)
Summer Haven Beach	1992	R 200-203	191,502
Summer Haven Beach	1999	R 200-208	222,000
Summer Haven Beach	2004	R200-208	214,475
Summer Haven Beach	2007	R200-208	187,862

*St. Johns County, Florida Shore Protection Project*, The General Reevaluation Report with Final Environmental Assessment for the St. Johns County, Florida Shore Protection Project, March 1998, serves as a post-authorization change report authorizing the HSDR project at St. Augustine Beach, approximately 10 miles north of the northern Flagler County border. The project includes the construction of a 60-foot berm along St. Augustine Beach from FDEP monuments R137 to R150, approximately 2.5 miles. Initial construction of the project in 2003 required placement of approximately 2,100,000 cubic yards of design fill and 1,600,000 cubic yards of advance material. Subsequent renourishments have taken place in 2005 and 2012.

## 1.7 Planning Process and Report Organization

Plan formulation detailed in this report follows an iterative planning process. The planning process consists of six major steps: (1) specification of problems and opportunities; (2) inventory, forecast and analysis of existing conditions within the study area; (3) formulation of alternative plans; (4) evaluation of the effects of the alternative plans; (5) comparison of the alternative plans; and (6) selection of the recommended plan based upon the comparison of the alternative plans. Being iterative, steps can be repeated as problems become better understood and new information becomes available.

Organization of this report generally follows Exhibit G-7 (Feasibility Report Content) provided in Appendix G of ER 1105-2-100 (30 June 2004). Planning step 2 is covered in chapters 1-3 which lay out the study background and existing conditions of the specific study area as well as future conditions without Federal participation. This gives the reader the background necessary to more fully understand the problems and opportunities (step 1). The problems and opportunities are detailed in chapter 4. The formulation, evaluation, and comparison of alternative plans covered in steps 4 and 5 will be discussed in chapter 5. The recommended plan selected in step 6 will be detailed in chapter 6.

This report documents the Flagler County, HSDR Feasibility study process, which includes the Marineland, Painters Hill, Beverly Beach, and Flagler Beach reaches from study initiation through formulation, alternative evaluation, and plan recommendation. It also serves as the environmental document for compliance with NEPA. The U.S. Army Corps of Engineers (USACE) planning process ensures adherence to applicable state and Federal laws, regulations and policy. The chapter headings and order in this report generally follow the outline of an Environmental Assessment (EA), thereby integrating the EA into the Feasibility Study report.

# CHAPTER 2 EXISTING CONDITIONS



**Marineland**  
relatively stable shoreline  
with large granite revetment



**Painters Hill**  
erosion threatening  
oceanfront homes



**Beverly Beach**  
erosion threatening oceanfront  
homes and State Road A1A



**Flagler Beach**  
erosion threatening homes, businesses,  
and State Road A1A; failing revetment



FLAGLER COUNTY, FLORIDA  
HURRICANE AND STORM DAMAGE REDUCTION PROJECT  
FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

**CHAPTER 2**  
**EXISTING CONDITIONS**

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\* Items required for an Environmental Assessment by the National Environmental Policy Act

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## 2 EXISTING CONDITIONS

### 2.1 General \*

This chapter describes conditions as they currently exist within the Marineland, Painters Hill, Beverly Beach, and Flagler Beach study reaches. Information gathered in this step helps to describe the existing problems and opportunities and forecast future conditions. The following paragraphs summarize research into studies and data collection efforts conducted for this project.

### 2.2 Physical Conditions \*

The Flagler County study area encompasses approximately 18 miles of sandy shoreline, located on a coastal barrier island that varies in width from approximately 800 to 5,000 feet. Refer to **Figure 2-1**. The Flagler County coastline is devoid of inlets or embayments and is part of a barrier island and mainland complex that extends uninterrupted for a length of 50 miles from Matanzas Inlet in the north to Ponce de Leon Inlet in the south. It is the longest barrier island in Florida (Bush et al, 2004). The Matanzas Inlet is located approximately 2.4 miles north of Flagler County in St. Johns County, and the Ponce de Leon Inlet is located about 27 miles south of Flagler County in Volusia County. Flagler County's coastal area is bound by the Matanzas River to the north, Smith Creek and the Intracoastal Waterway (IWW) to the west, and Volusia County beaches to the south.

Flagler County beaches are typically fronted by a line of dunes which range in height from 10 to 23 feet Mean Sea Level (MSL). The dunes are characterized by relatively steep faces composed primarily of coquina shell hash and fine quartz sand. Periodic natural coquina rock outcroppings are present, especially along the northern beaches in the Marineland reach. The coquina rock is exposed in the supratidal area and in the intertidal zone at low tide along sections of the northern beaches between Florida Department of Environmental Protection (FDEP) Monuments R3 and R16. Another section of exposed outcrop is located between R-20 and R- 43. Other sections of rock are suspected to exist in the subtidal zone along the shoreline but are likely covered with sand (DEP, 1999). The rock is semi-erodible providing a source of beach shell hash that is present along the Flagler County shoreline.

While Flagler County has significantly armored sections of its shoreline to provide some level of erosion and storm damage protection to threatened areas, the county remains one of the least armored shores along Florida's east coast (Bush et al, 2004). U.S. Army Corps of Engineers (USACE) shoreline surveys in February 2009 revealed prominent sections of shoreline armor in Flagler County. **Table 2- 1** summarizes the findings of the shoreline armor survey. **Figure 2- 1** displays several of these areas.

**Table 2- 1: Summary of shoreline armoring in Flagler County, Florida**

Reach	R-Monument	Length (ft)	Description
Marineland	R1 – R2	1350	Granite revetment at Marineland.
Marineland	R1 – R3	na	Five partially removed coquina groins.
Marineland	R2 – R3	1500	Steel seawall currently covered by dune and boardwalk.
Varn Park	R49.3 – R49.5	260	10' tall stand-alone seawall with no structures behind the wall.
Beverly Beach	R60.5 – R62.4	1560	Concrete seawall at Camptown RV park, starting at Windward Drive, continuing south.
Flagler Beach	R78.6 – R79.4	565	South 2 <sup>nd</sup> Street to South 4 <sup>th</sup> Street. Small section of aging seawall at the Flagler Pier.
Flagler Beach	R80 – R90	9240 (1.75 miles)	Flagler Beach Revetment constructed in sections of coquina and granite. Mostly failing.
Flagler Beach	R82	153	Concrete capped steel sheet pile seawall at South 13 <sup>th</sup> Street.
Flagler Beach	R94.6 – R94.8	152	Small concrete seawall fronting a restaurant and a dilapidated wooden seawall fronting the residence to the north.

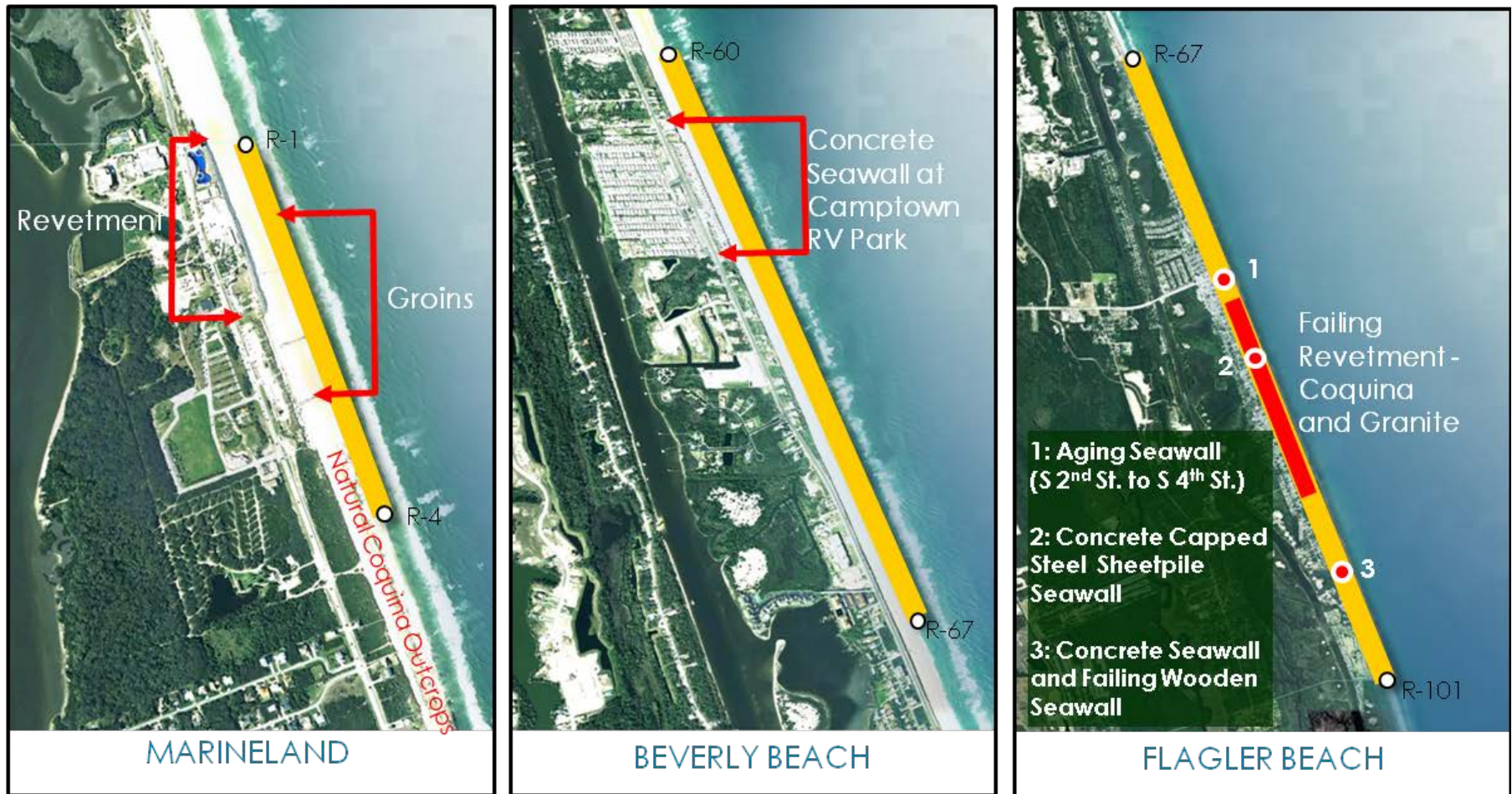


Figure 2- 1: Flagler County Shoreline Armoring

As shown in **Figure 2- 1**, the most significant sections of shoreline armor exist in the Marineland and Flagler Beach study reaches. At Marineland, a 1,350-foot long section of granite revetment protects the aquatic park between FDEP monuments R-1 and R-3. In Flagler Beach, an approximately 1.75 mile long rock revetment, built by the Florida Department of Transportation (FDOT), is meant to protect State Road A1A (SR A1A). The revetment along Flagler Beach has been constructed in sections beginning in 1984 following a season of severe northeaster storms. The revetment was improved and extended in 1999 following Hurricane Floyd and again in the spring of 2002. Currently, most of this revetment is in very poor condition and not functioning to its specifications. FDOT completed a Project Development and Environmental (PD&E) study in January 2010 to assess the feasibility of providing shoreline protection along Flagler Beach to protect SR A1A. The PD&E recommends that efforts to protect a 5.2-mile stretch (R-64 to R-94) of SR A1A in Flagler Beach be constructed on an as needed emergency basis. Construction would consist of using sand, rock, or seawall, within the FDOT right of way, to protect the road depending on available funding and the severity of road conditions. FDOT efforts to protect SR A1A are limited by available funding and limited to methods that can be constructed and maintained within FDOT's jurisdictional right-of-way which extends only 50 feet from the centerline of the roadway. The U.S. Fish and Wildlife Service (FWS) issued a Biological Opinion (BO) to FDOT to implement the above construction methods within the FDOT right of way. These limitations, along with continued dune erosion, make the roadway difficult to protect. **Appendix C** describes specifications of existing armor.

### 2.2.1 Study Reaches

The approximately 9.6-mile long study area is separated for analysis into 4 study reaches based on the areas' status as critically eroded by the FDEP (2008). The extent of each of the 3 southern reaches has been expanded beyond the FDEP designated areas in order to incorporate data collection and study of the relatively small areas of shoreline between the FDEP designated sections. Analysis of the entire southern half of the county, to include the small areas between the FDEP designated sections, will account for potential future expansion of the critically eroded areas.

The Marineland reach is located at the northernmost extent of Flagler County, between FDEP R monuments R-1 and R-4. The area between R-4 and R-50, locally referred to as "The Hammocks," is not included in this study. This area is not significantly threatened by shoreline erosion because most of the coastal structures are set back considerably from the shoreline and are protected by an undisturbed and well vegetated dune system. Along the southern half of the county between FDEP R monuments R-50 and R-101 are the Painters Hill, Beverly Beach, and Flagler Beach study reaches of this study. This feasibility study concentrates on 9.6 of the approximately 18 total miles of Flagler County coastline.

## Marineland

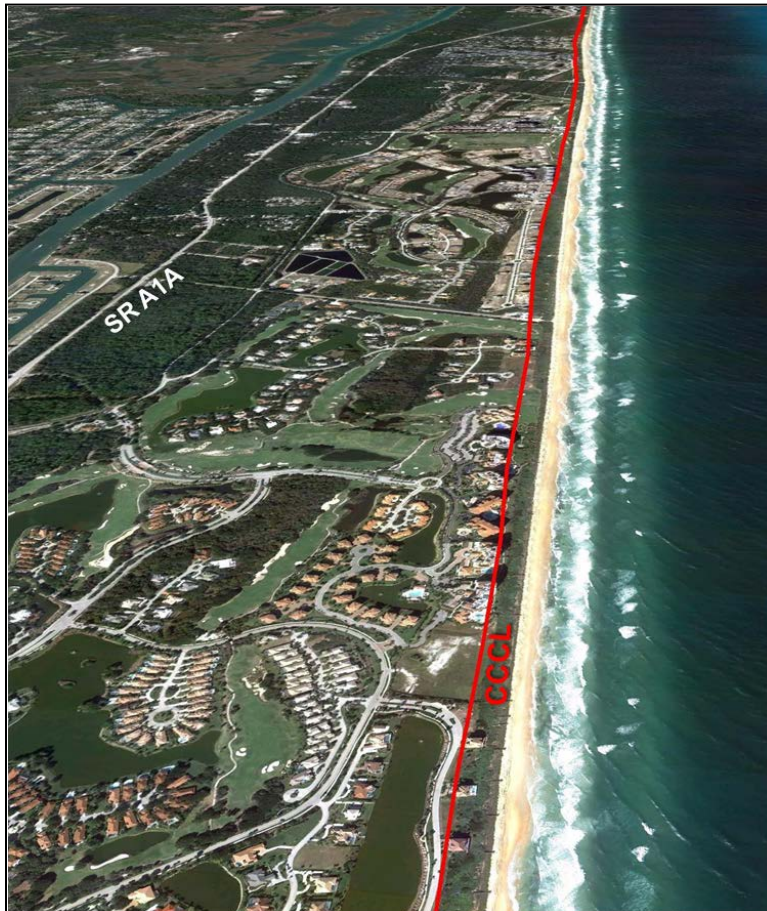
The Marineland reach extends south from Summer Haven in St. Johns County through the northern 0.63 miles of Flagler County. The Marineland Oceanarium is protected by a 1,350-foot granite revetment (**Figure 2-2**), and the remnants of 5 small coquina groins located south of the revetment. Shoreline change rate estimates (FDEP, 1999) indicate that this reach has remained relatively stable since at least 1952, likely due to the presence and functioning of the revetment and groins.



**Figure 2-2: The 1,350-foot long granite revetment and one partially buried coquina groin in the Marineland study reach. Three more coquina groins exist to the south of the revetment.**

### The Hammocks (provided for informational purposes, not a study reach)

The Hammocks and area to the south (**Figure 2-3**) extends from R-4 through R-50, with none of the shoreline in this reach designated as critically eroded by FDEP. There are no reports of significant damages caused by erosion in this area in recent history. In this area, SR A1A is located further inland in comparison to the rest of the county where the road runs directly along the coast. The shorefront in this area consists of Washington Oaks Gardens State Park, single family residences, Hammock Park, condominiums, resorts, golf courses, Varn Park, and undeveloped parcels. The shorefront structures are buffered by a dune system that is wider than in other areas of Flagler County. Coquina rock outcroppings, an important natural resource located on the beach in this area also provides a natural defense against erosion. Coquina rock outcroppings are described in more detail in **Section 2.4.4**. Many of the structures in this area are relatively newer than the rest of the coastal development in the county, and have been built landward of the Coastal Construction Control Line (CCCL) for Flagler County (established in 1988 by FDEP to protect beaches and dunes from imprudent construction).



**Figure 2-3: December 2010 Google aerial of The Hammocks area with the Coastal Construction Control Line (CCCL) overlaid in red showing the set back of newer development.**

## Painters Hill

The Painters Hill study reach (**Figure 2-4**) extends from R-50 through R-60. A single row of homes sits atop the dune east of SR A1A through much of Painters Hill. Continuous erosion in this vicinity has caused the dune adjacent to these homes to become degraded or nonexistent. Undeveloped lots east of SR A1A consist of a vegetated dune with a steep face. In December 2007, surf swells generated by Tropical Storm Olga in combination with high astronomical tides and a full moon, eroded away a patio, a hot tub, and a septic tank and put at least three homes in imminent danger of being undermined and destroyed. The beach erosion which threatened several of the homes in the Painters Hill community during this 2007 event resulted in Flagler County declaring a State of Local Emergency. Following this event, up to 25 homeowners attempted to obtain permits from the Flagler County Building Department and FDEP to construct temporary protective measures for their oceanfront homes.



**Figure 2-4: Beach erosion in Painters Hill following the December 2007 storm event.**

## Beverly Beach

The Beverly Beach study reach (**Figure 2-5**) extends from R-60 through R-66, with the area from R-65.2 to R-70.0 designated as critically eroded by FDEP (2008). Like Painters Hill, a single row of homes sits atop the dune east of SR A1A through much of Beverly Beach. Continuous erosion in the vicinity of these homes has caused the dune adjacent to these homes to become degraded or lost. Undeveloped lots east of SR A1A consist of a vegetated dune with a steep face. A 1,560-foot long concrete seawall fronts



the Camptown RV Park from R-61 to R-62 where the dune is nonexistent. In the southern portion of the Beverly Beach reach, between R-65.2 through R-70, SR A1A lies within 50 to 100 feet of the mean high water line, putting the road in danger of being undermined by a severe erosion event and prompting the FDEP to designate this section as critically eroded in 2008. Loss of a section of A1A in Beverly Beach would affect local residents' only hurricane evacuation route.



**Figure 2- 5: State Road A1A at the border of the Beverly Beach and Flagler Beach reaches immediately after Tropical Storm Fay in August 2008. Sand has been washed over the dune and deposited on the road.**

### Flagler Beach

The largest reach in the study area is Flagler Beach which stretches 6.15 miles from R-67 to R-101. A portion of the reach from R-76.0 through R-94.8 is designated as critically eroded by FDEP (2012). In Flagler Beach, large portions of SR A1A are in imminent danger of being destroyed and many sections are damaged annually by the eroding shoreline (**Figure 2-6**). The development in Flagler Beach east of SR A1A consists of dune walkovers throughout the reach, the Flagler Beach Pier, and a parking lot at the southern end of the reach. Since 1984, measures have been taken by Flagler County and the FDOT to protect SR A1A, including construction of a rock revetment (reconstructed and repaired several times since its initial construction due to storm damage) and a 153-foot long concrete seawall (**Figure 2-7**). During a post-storm inspection in 2009, sections of SR A1A in southern Flagler Beach were documented as within 75 feet of the water line during low tide (USACE, 2009), **Figure 2-8**. Erosion in this reach also poses a threat to commercial and residential structures including homes, a pier, restaurants and shops. The dune is mostly degraded or nonexistent throughout most of Flagler Beach.



**Figure 2-6: Looking west along SR A1A near R-68 on 23 August 2008, after Tropical Storm Fay. The rocks on the right side of the image were placed by FDOT as an emergency measure to protect SR A1A from being undermined by waves. Also, the sand on the road is a result of a complete wash over during the storm.**



**Figure 2-7: Aging seawall and revetment protecting SR A1A from the eroding shoreline in Flagler Beach.**

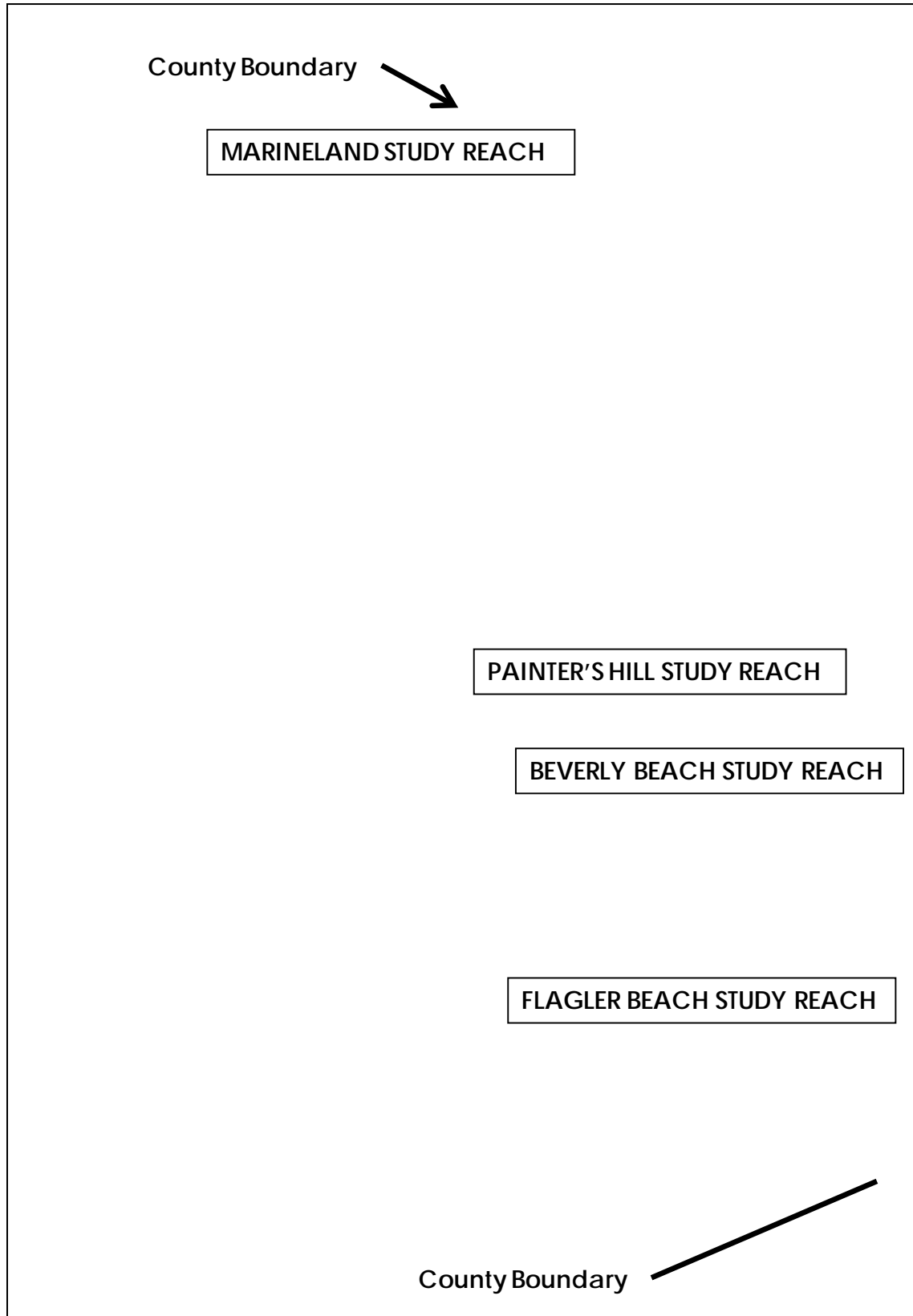


**Figure 2-8: Looking south from 19<sup>th</sup> Street South in Flagler Beach on 24 May 2009. This image was taken during low tide and the distance between A1A and the waterline was measured as approximately 75 feet. Notice the failing revetment and visible geotextile fabric which is meant to line the underside of the revetment.**

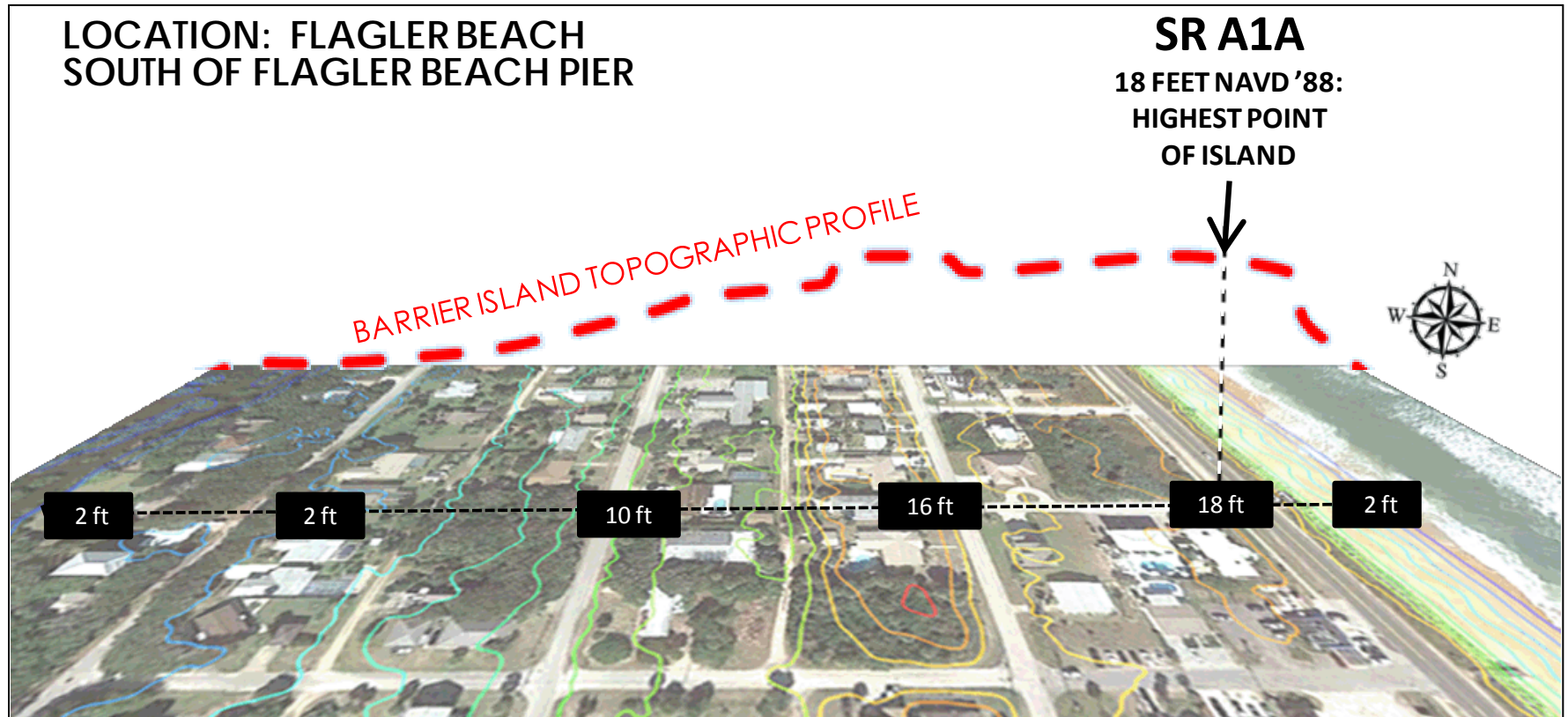
### 2.2.2 Hurricane Evacuation Routes and Zones

Hurricane evacuation zones in Florida are defined by the county emergency management agencies, based on the expected inundation areas and definable boundaries. The entire study area is located in an “A” evacuation zone, meaning that this area would potentially be inundated by storm surge associated with a Category 1 Hurricane. Zone A in Flagler County had a 2010 population-at-risk of 14,258 persons. SR A1A is the only north-south evacuation route for the area. The evacuation zones and routes for coastal Flagler County are shown in **Figure 2-9**. (FDEM 2010)

Throughout most of the study area, SR A1A is located on the highest elevation on the barrier island. Other roads that exist at lower elevations are more vulnerable to inundation, and during a flood event these other roads will be flooded before SR A1A. **Figure 2-10** shows a typical cross section of the barrier island with SR A1A located at the highest elevation. SR A1A also serves as an important route for emergency vehicles and recovery efforts following natural disasters.



**Figure 2-9: Evacuation Routes and Zones in the Study Area.**



**Figure 2-10: Barrier Island Profile.**

### 2.2.3 Undeveloped Parcels (Lots)

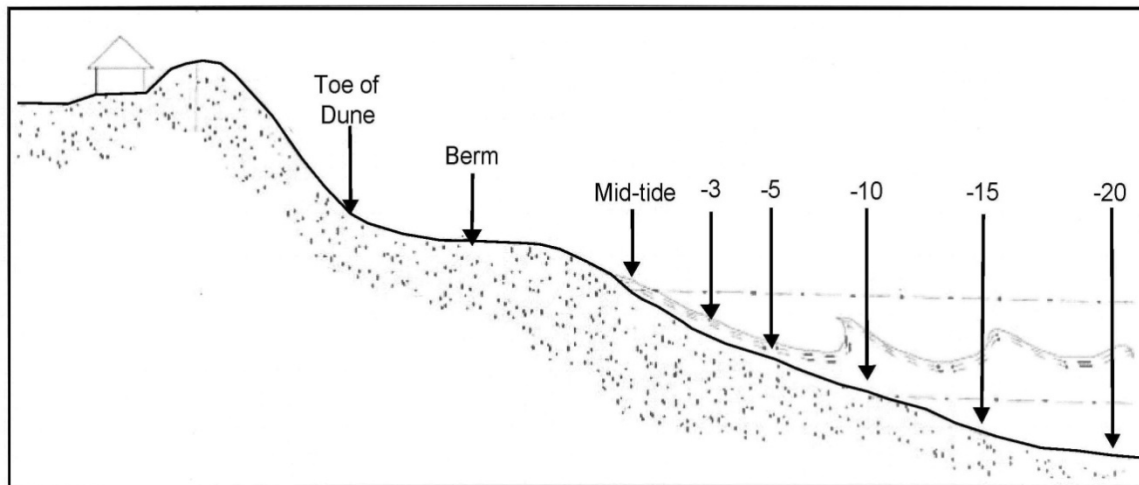
Based on 2008 aerials the southern 685 feet of the Marineland study reach is undeveloped constituting approximately 25% of the reach. There are 33 undeveloped parcels in the Painter's Hill and Beverly Beach study reaches comprising approximately 4,070 linear feet of shoreline (**Figure 2-11**), and about 27% of these two study reaches. The Flagler Beach study reach is considered fully developed with SR A1A being the most seaward damage element other than the Flagler Beach Pier, dune walkovers, and facilities at Gamble Rogers State Park.



**Figure 2-11: Undeveloped parcels in the study area.**

### 2.2.4 Native Beach

Beach sediment sampling was performed by USACE in August 2012 along representative beach profile lines. Beach sediment samples were collected along the profile lines at the following locations as shown in **Figure 2-12**: toe of dune, berm, mid-tide, and -3, -5, -10, -15, and -20 feet below Mean Sea Level.



**Figure 2-12: Beach Transect with Beach Sampling Locations**

Due to severe erosion, only some of the beaches reflect this typical profile. At some locations, the dune is replaced by revetment, and therefore no sample was collected.

All samples were analyzed for grain size, visual shell, and color. Carbonate analysis was performed on representative samples. The associated gradation curves and granulometric reports are presented in the **Geotechnical Appendix**. An arithmetic composite sample was created from all samples.

Results characterize the sediments at Flagler Beach as poorly-graded, fine-grained quartz sands. The mean grain size ranges between 0.14 mm (2.84 phi) and 0.67 mm (0.58 phi) averaging at 0.28 mm (1.85 phi). The carbonate content ranges from 8% to 64% averaging at 25%. The visual shell averages 23%, and the color of the sand is generally light gray to pinkish gray. Samples collected at the berm and at mid-tide locations have especially high shell contents caused by the deposits from the Anastasia formation, which also causes the unique color of the Flagler County beaches.

### 2.2.5 Offshore Sand Borrow Sources

Three offshore borrow areas were investigated for potential nourishment of Flagler County beaches (**Figure 2-13**). Of these three areas, Area 1, located approximately 2 miles off-shore and partially within Outer Continental Shelf (OCS) waters, did not reveal

sufficient quantities of beach compatible material for the entire life-cycle of the project during a 2009 geotechnical survey conducted by Flagler County.

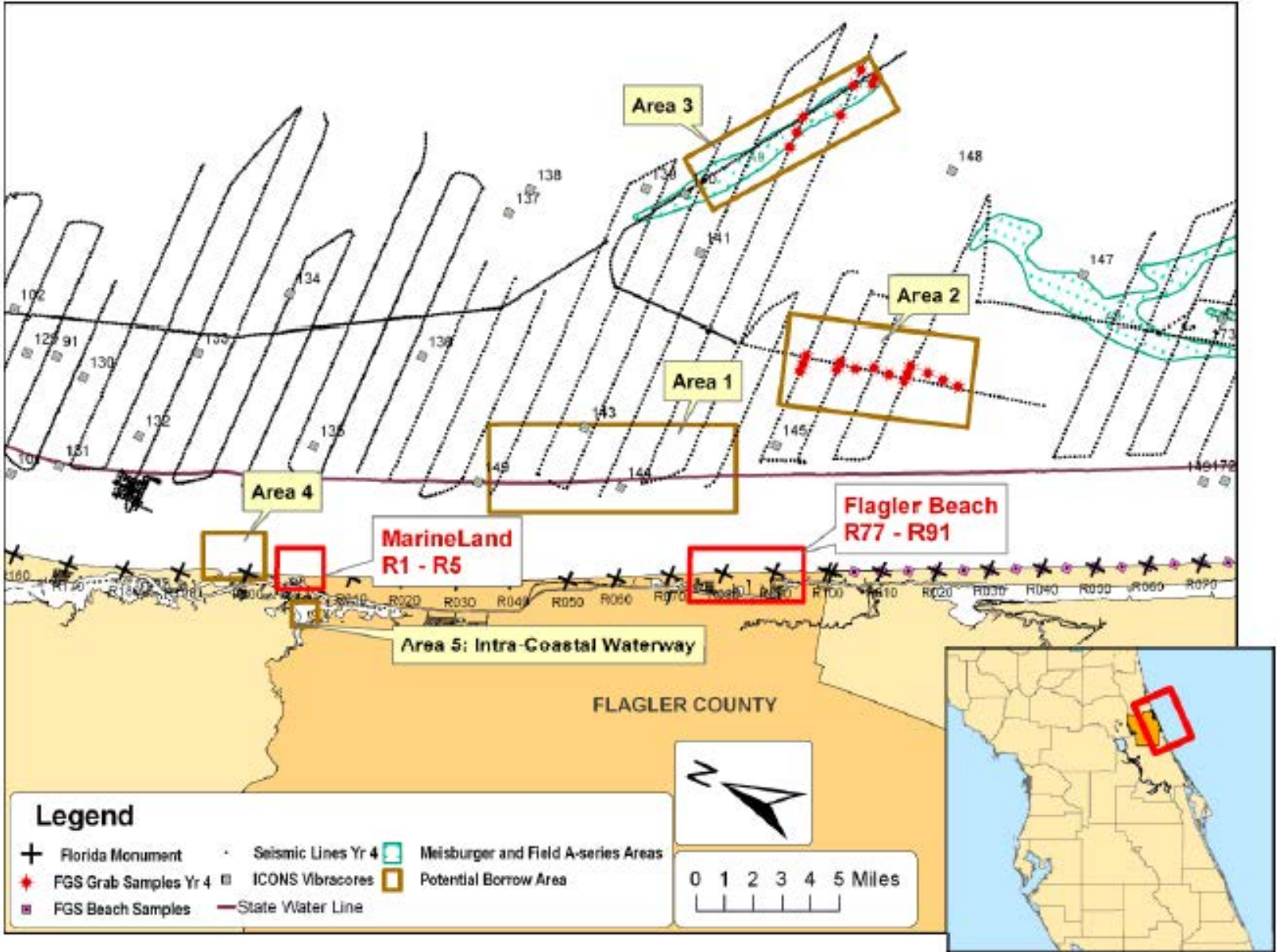
Another source, Area 4, is in the Matanzas Inlet and the adjacent Intracoastal Waterway (IWW). USACE periodically dredges this area and typically places the material on Summer Haven Beach, directly south of the inlet or in an upland disposal area (SJ-1) which is periodically offloaded to Summer Haven Beach. Since it is much more economical to place the material on Summer Haven due to its close proximity, it is highly unlikely that it would be cost effective to transport the relatively small amount of dredged material (approximately 200,000 cubic yards every 5 years) to a potential project in Flagler County with the exception of a project located in Marineland.

Two other areas -- Area 2 and Area 3 -- are located approximately 6-7 miles and 12-14 miles offshore in OCS waters, respectively. These two areas, under sole Federal jurisdiction of BOEM, were investigated in 2011 by USACE.

The purple line in **Figure 2-13** marks the boundary between state waters within 3 miles of the shore and the Outer Continental Shelf (OCS) waters outside of 3 miles from the shore on the Atlantic Coast. The Bureau of Ocean Energy Management (BOEM) has sole jurisdiction of sand sources in OCS waters.



Figure 2-13: Locations of potential borrow areas (Halcrow 2010).



Both Area 2 and Area 3 borrow sources contain beach compatible sand, however considering the lower transportation costs, Area 2 is proposed as the primary sand source for Flagler County shoreline protection measures.

Borrow Area 2 is part of the Korona Ridge Field geomorphologic unit and was investigated by the USACE in 2011. Sand ridges are elongated shoals of mostly sandy sediments that have been heaped up by currents to form linear mounds. In general, sand ridges tend to be semi-permanent features that migrate with the current slowly over time. Area 2 revealed beach compatible sand at three distinct locations: Sub-areas 2A, 2B, and 2C. Borrow Sub-areas 2A and 2B have a combined volume of beach compatible sand of approximately 3 million cubic yards, and borrow Sub-area 2C contains about 2.6 million cubic yards of material. The three borrow sub-areas are depicted in **Figure 2-14**, and details are summarized in **Table 2-2** below.

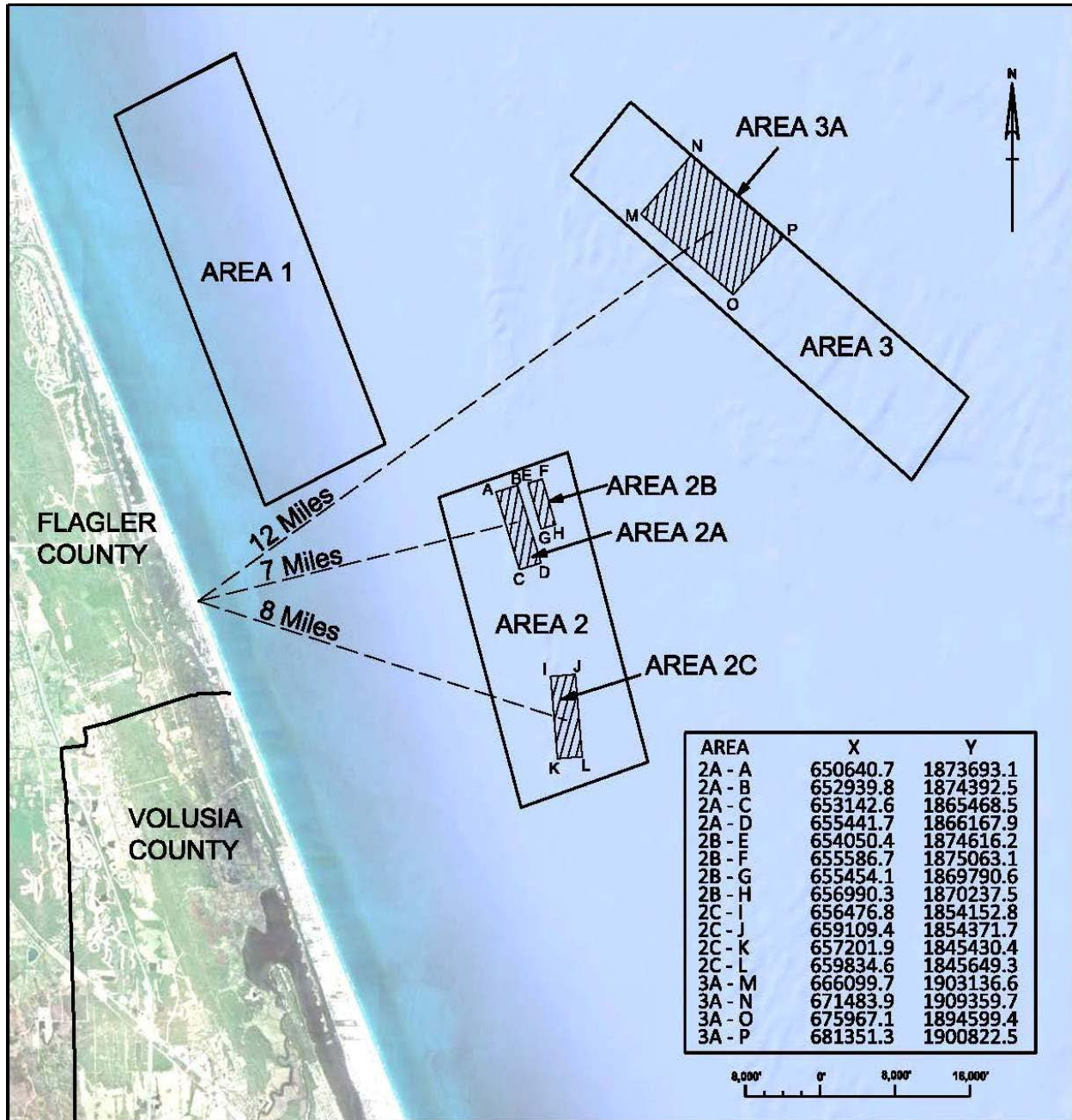


Figure 2-14: Borrow sub-areas 2A, 2B, 2C, and 3A

**Table 2-2: Details for Proposed Borrow Area 2A, 2B, and 2C**

Sub-area	Approximate Size (feet)	Approximate Volume (cubic yards)	Borings	Boring Elevation (ft. NAVD)
2A	5,000 x 1,700	1.7 mil	VC-FSP11-14,	-58
			VC-FSP11-16	-53
2B	3,300 x 1,500	1.3 mil	VC-FSP11-15	-62
2C	7,000 x 2,000	2.6 mil	VC-FSP11-22	-52

Four 20-foot vibracores (VC-FSP11-14 through VC-FSP11-16, and VC-FSP11-22) were collected in February 2011 at proposed Borrow Sub-areas 2A, 2B, and 2C, as depicted on **Table 2-2**. Thicknesses of the beach compatible sand layers vary from 5 to 18 feet. Conservative values between 5 and 7 feet below seafloor surface were used as dredging depths for the calculation of the volume estimates. However, the indicated dredging depths may change with the availability of additional testing results. Results characterize the sediments in all the samples as poorly-graded, fine-grained sands with an average of 19% visual shell and 15% carbonate content. The mean grain size ranges between 0.17 mm and 0.65 mm, averaging 0.26 mm. The average standard deviation is 1.01 phi. The amount of fines passing the #230 sieve averages around 2.89 %. The Munsell color of the wet sand is 5Y 5/1; the dry sand color is N 7/1.

Results from samples taken on Flagler Beach characterize the existing beach sediments as poorly-graded, fine-grained quartz sands. The mean grain size ranges between 0.14 mm (2.84 phi) and 0.67 mm (0.58 phi) averaging at 0.28 mm (1.85 phi). The carbonate content ranges from 8% to 64% averaging at 25%. The visual shell averages 23% and the color of the sand is generally light gray to pinkish gray. Samples collected at the berm and at mid-tide locations have especially high shell contents caused by the deposits from the Anastasia formation, which also causes the unique color of the Flagler County beaches.

Based on the findings of the geotechnical survey along with consideration of transportation costs, Area 2, with Sub-areas 2A, 2B, and 2C, is proposed as the primary source for Flagler County shoreline protection measures requiring a sand source. The source meets Florida Administrative Code 62B-41.007(2) (the "Sand Rule") which requires that sand for beach nourishment meet the following requirements:

- Carbonate or quartz with a particle size between 0.062 and 4.76mm
- <5% silt passing the #230 sieve
- <5% gravel sized shell retained on the #4 sieve
- Fill material must be free of foreign matter, debris, toxic material
- Fill material shall be similar in color and grainsize distribution

A topic of local concern is maintaining the existing sand color of the beaches. The Flagler County beaches have a surface layer containing especially high shell content caused by deposits from the Anastasia formation. This “shell hash” lies on top of quartz sand and causes the unique orangish color of the beaches. A beach nourishment project using the proposed borrow area would cover the existing beach with sand containing a mixture of quartz and shell hash, likely to initially result in a beach with a less dramatic orange shell hash lens. However, over time coastal processes should naturally sort the nourishment sand, sifting the smaller diameter quartz grains below any shell hash resulting in beach sand of a color similar to existing beaches. This process would repeat after each renourishment.

Detailed information regarding the geotechnical characteristics of the borrow areas as well as recipient beach placement areas is presented in the **Geotechnical Appendix D**.

A submerged resource survey of the proposed borrow sources was conducted in February of 2013, by the USACE Jacksonville District Hydrographics Survey Section, Operations Division. The survey consisted of sidescan sonar and encompassed the Sub-borrow areas 2A, 2B, and 2C. The results of the survey determined that no hardbottom or other anomalies are present within the three sub-areas; the data show a featureless homogenous blanket of sand in the borrow area limits. Please see the **Environmental Appendix F** for details of these surveys.

### 2.2.6 Compatibility of Potential Borrow Areas with the Beaches

Grain size distribution, overfill, and renourishment factor computations were used to determine if the proposed borrow areas 2A, 2B, 2C and 3A are compatible with the native beach. The grain size analysis revealed that the sediments of the borrow areas are composed of fine-grained quartz sand with visual shell values between 12% and 23%. The beach is also composed of fine-grained quartz sand with a visual shell value of 23%. Overfill and renourishment factors were calculated for each of the borrow areas using a USACE software program. Borrow areas 2A, 2B, and 3A showed overfill factors well below 1.3 and renourishment factors below 1.1 and are therefore suitable for Flagler County beaches. The material from borrow area 2C is too fine and too poorly sorted to be compatible with Flagler County's beaches. However it could still be used if mixed with sediments from the other proposed borrow areas. Also, additional investigation could reveal coarser material in borrow area 2C.

### 2.2.7 Shoreline Change

Flagler County is unique compared to the counties to the north and south in that the shoreline sediment contains a higher percentage of coarse shell hash which produces a larger median grain size and steeper beach profiles. The shoreline has mild concave curvature from north to south, transitioning to a headland at Flagler Beach. Shoreline irregularities along the generally curved shoreline are attributed to nearshore hard bottom exposed rock outcrops which influence shoreline erosion and accretion. A FDEP shoreline change rate study conducted in July of 1999 concluded that the beaches of Flagler County are subject to cyclic erosion and accretion but are relatively stable based on data from 1952 to 1993.

Refer to the **Engineering Appendix A** for additional detail on historical changes of the Mean High Water (MHW) line and volume change in the study area.

The position of the MHW line varies along the Flagler County project shoreline, with relatively small rates of change over the time period between 1972 and 2007. Shoreline change rates for this period range from +1.06 to -2.40 feet per year with isolated areas of moderate erosion and accretion. Factors which contribute to this variation include the distribution of exposed rock in the surf zone and foreshore slope, as well as structures in the area. One structure of particular influence on longshore transport and beach erosion and accretion is the Flagler Pier at R-79. The pier tends to trap sand from longshore transport causing accretion north of the pier, as well as downdrift erosion about 2,000 feet south of the pier due to the interruption of longshore transported sand. From 1972 to 2007 the MHW rate of change was generally erosional along the study limits with annual erosion rates of -0.58 feet per year in the north project segment (R1 to R-4) and -0.59 feet per year in the south project segment (R-50 to R-100). **Table 2-3** provides a further breakdown of annual shoreline rates of change by study reach.

Each of the study reaches, with the exception of Beverly Beach, have relatively consistent average shoreline rates of change, ranging from -0.58 feet per year to -0.67

feet per year. Due primarily to the stabilizing presence of a concrete and steel seawall over a significant portion of the reach, Beverly Beach experiences a lower shoreline rate of change, approximately -0.11 feet per year.

**Table 2-3: Annual Shoreline Rate of Change by Study Reach**

Project Segment	Study Reach	Location (DNR Monument)	MHW Rate of Change (1972 – 2007) (Feet/Year)
North	Marineland	R-1 to R-4	-0.58
TOTAL (North)		R-1 to R-4	-0.58
South	Painters Hill	R-50 to R-60	-0.64
	Beverly Beach	R-60 to R-67	-0.11
	Flagler Beach	R-67 to R-101	-0.67
TOTAL (South)		R-50 to R-101	-0.59
TOTAL (Project)		R-1 to R-4, R-50 to R-101	-0.59

### 2.2.8 Winds

Local winds are the primary means of generating the small-amplitude, short-period waves that are an important mechanism of sand transport along the Florida shoreline. Flagler County lies at about 29° degrees latitude, slightly north of the tropical trade wind zone. Winds in this region vary seasonally with prevailing winds ranging from the northeast though the southeast. The greatest velocities originate from the north-northeast quadrant in winter months and from the east-southeast quadrant in the spring, summer, and early fall.

Wind data offshore of the project area is available from the USACE Wave Information Study (WIS) Program. There are 523 WIS stations along the Atlantic Coast. WIS Station 63422 is representative of offshore deep water wind and wave conditions for the project area. **Table 2-4** provides a summary of wind data from WIS Station 63422, located at latitude 29.58, longitude -81.0 (about 3 miles northeast of Flagler Beach, **Figure 2-15**). This table contains a summary of average wind speeds and frequency of occurrence broken down into eight 45 degree angle-bands. This table indicates that winds are fairly evenly distributed between the northeast and south directions. Due to its orientation, winds from the north-northeast to south-southeast have the most significant impact on the Flagler shoreline.

**Table 2-4: Average Wind Conditions**

Wind Direction (from)	WIS Station #63442 (1980 – 1999)	
	Percentage Occurrence (%)	Average Wind Speed (mph)
North	10.3	14.0
Northeast	15.3	13.4
East	14.6	11.1
Southeast	12.6	10.0
South	14.5	10.4
Southwest	13.4	10.9
West	9.5	13.3
Northwest	10.0	15.1

Wind conditions in coastal Florida are seasonal. Between December and March, frontal weather patterns driven by cold Arctic air masses can extend as far as South Florida. These fronts typically generate northwest winds before the frontal passage, and northeast winds behind the front. This post-frontal "nor'easter" behavior is responsible for the increased intensity of wind speed seen in the northeast sector winds during the winter months. Northeasters may result in wave conditions that can cause extensive beach erosion and shorefront damage.

The summer months (June through September) are characterized by southeast trade winds and tropical weather systems traveling west to southwest in the lower latitudes. Additionally, daily breezes onshore and offshore result from differential heating of land and water masses. These diurnal winds typically blow perpendicular to the shoreline and have less magnitude than trade winds and nor'easters. Daily breezes account for the general shift to east/southeast winds during the summer months when nor'easters no longer dominate.

During the summer and fall months, tropical waves may develop into tropical storms and hurricanes, which can generate devastating winds, waves, and storm surge when they impact the project area. These storms contribute greatly to the overall longshore and cross-shore sediment transport at the site.

### 2.2.9 Waves

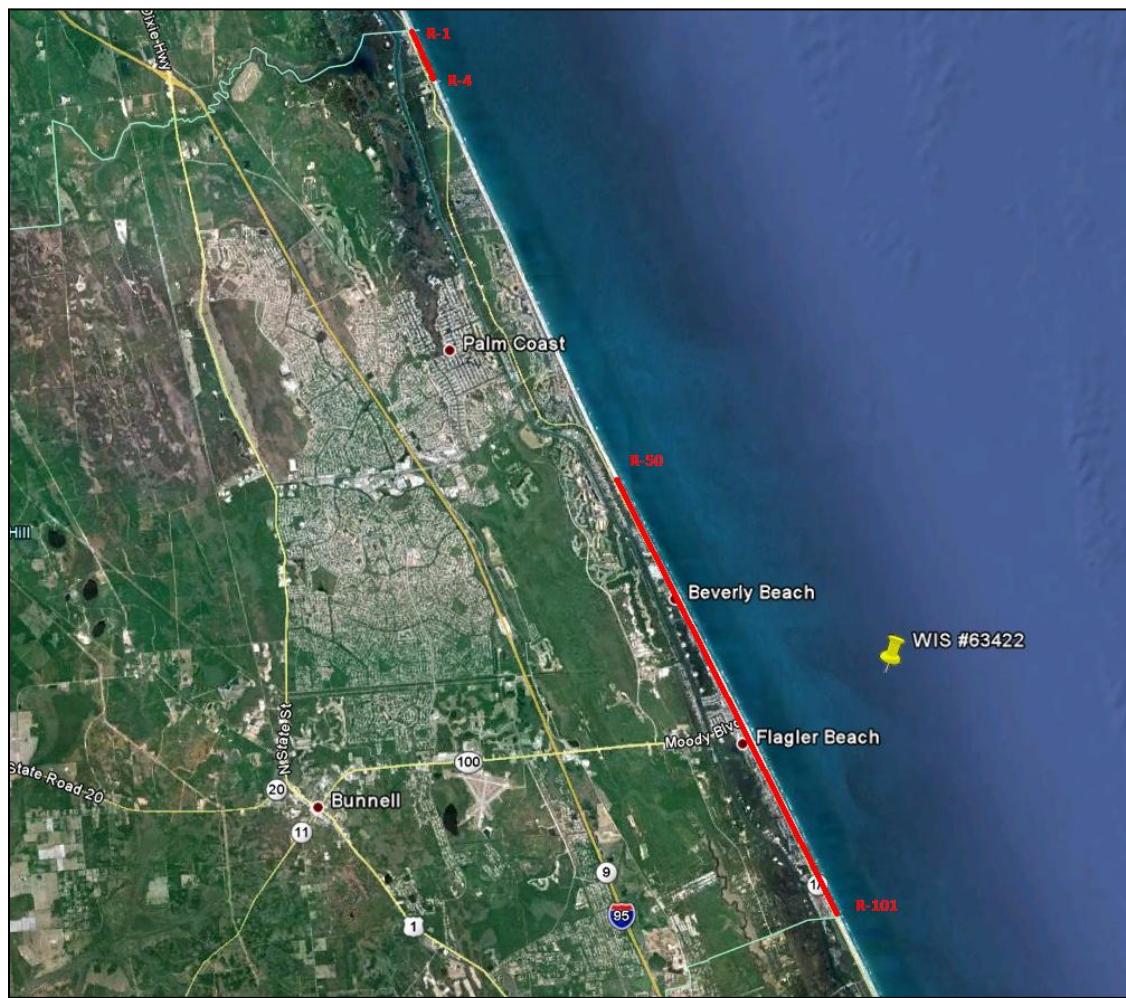
The energy dissipation that occurs as waves enter the nearshore zone and break is the principal method of sediment transport. Wave height and period, in combination with tides and storm surge, are the most important factors influencing the behavior of the shoreline. The Flagler County study area is exposed to both short period wind-waves and longer period open-ocean swells originating predominantly from north-northeast to south-southeast directions.



Damage to the Flagler County shoreline and upland development is attributable to large storm waves produced primarily by tropical disturbances, including hurricanes, during the summer months and by nor'easters during the late fall and winter months.

Because the study area is fully exposed to the open ocean in all seaward directions, the coastline is vulnerable to wave attack from distant storms, as well as local storms. Most hurricanes and tropical storms traversing northward through the Atlantic within several hundred miles of the east coast are capable of producing large swells. These swells can propagate long distances, causing erosion along the Flagler County shoreline.

Wave data for this report was obtained from the long-term USACE WIS hindcast database for the Atlantic coast of the U.S. This 20-year record extends from 1980 through 1999, and consists of a time-series of wave events at 3-hour intervals for stations located along the east and west coasts of the United States, as well as the Gulf of Mexico and the Great Lakes. The WIS station closest to the project area is #63422, located 3 miles offshore of the study area in 66 feet of water. The location of WIS station #63422 relative to the study area is shown in **Figure 2-15**.



**Figure 2-15: Location of WIS Station #63422 relative to project.**

**Table 2-5** summarizes the percentage of occurrence and average wave height of the WIS waves by direction. It can be seen that the dominant wave directions range from northeast to southeast. This reflects both the open ocean swell and more locally generated wind-waves.

Similar to wind conditions, wave conditions in coastal Florida experience seasonal variability. The seasonal breakdown of wave heights provided in **Table 2-6** shows that late fall and winter months have an increase in wave height due to nor'easter activity. The intensity and direction of these fall/winter wave conditions are reflected in the dominant southward sediment transport and seasonal erosional patterns in the project area. In contrast, summer months experience milder conditions, with smaller wave heights. Overall, waves originating from the east to northeast quadrant dominate.

**Table 2-5: Average Wave Heights (1980 to 1999)**

Wind Direction (from)	WIS Station #63422 (1980-1999)	
	Percentage Occurrence (%)	Average Wave Height (ft)
North	9	4.5
Northeast	24	4.5
East	51	3.3
Southeast	12	2.7
South	2	3.1
Southwest	1	2.9
West	0	3.0
Northwest	2	3.6

**Table 2-6: Seasonal Wave Conditions**

Month	WIS Station #63422 (1980-1999)	
	Average Wave Height (ft)	Predominant Direction (from)
January	4.09	E-NE
February	4.07	E-NE
March	3.83	E-NE
April	3.33	E-NE
May	3.04	E-NE
June	2.61	E
July	2.24	E-SE
August	2.79	E
September	3.81	E-NE
October	4.58	E-NE
November	4.53	E-NE
December	4.15	E-NE

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Wave periods have the same seasonality as wave heights. Wave period is the time between two waves passing through a stationary point, typically measured in seconds. **Table 2-7** provides a seasonal breakdown of percent occurrence by wave period. From this table, it can be seen that short period, locally-generated wind waves are common throughout the year. The yellow highlighted values show the dominant wave period for each month. None of these dominant periods are less than 5.0 seconds or greater than 6.0 seconds. It can also be seen that in the summer months the shortest period waves occur more frequently. During the fall and winter months more frequent higher-energy, longer-period storm swells occur. Note that the percentage of waves with periods greater than 12.0 seconds increases from a low of 0.3% in June to a high of 13.4% in September (the height of hurricane season).

Table 2-7: Wave Period – Percent Occurrence

Wave Period (Sec)	Percent Occurrence by Wave Period Band											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
< 4.0	6.0	5.2	6.2	6.7	5.0	8.3	10.0	5.3	3.1	1.3	3.2	4.4
4.0 - 4.9	10.1	10.8	10.5	9.6	8.0	4.2	3.8	4.4	6.2	4.0	7.0	8.3
5.0 - 5.9	18.3	22.1	20.0	22.0	25.2	36.2	37.3	40.3	26.9	24.9	20.5	21.5
6.0 - 6.9	12.5	13.5	14.3	15.0	19.2	24.7	28.7	25.3	17.9	21.6	17.3	15.5
7.0 - 7.9	13.5	14.4	14.5	13.6	19.1	14.8	13.4	12.2	12.0	16.3	14.9	11.9
8.0 - 8.9	7.9	6.8	6.5	7.3	5.4	3.9	2.4	1.8	4.9	5.8	8.5	5.6
9.0 - 9.9	8.4	8.0	6.6	7.0	5.1	3.3	1.8	1.3	4.6	6.8	7.0	5.7
10.0 - 10.9	8.0	6.3	6.2	5.9	4.4	3.0	1.3	1.6	5.0	6.1	6.8	8.1
11.0 - 11.9	6.2	5.8	6.1	6.3	5.0	1.4	1.0	2.0	6.0	6.2	6.9	7.1
> 12.0	9.1	7.4	9.3	6.7	3.6	0.3	0.4	5.8	13.4	7.1	7.9	11.9

### 2.2.10 Tides and Currents

Astronomical tides are created by the gravitational pull of the moon and sun and are entirely predictable in magnitude and timing. The National Oceanic and Atmospheric Administration (NOAA) regularly publishes tide tables for select locations along the coastlines of the United States and select locations around the world. These tables provide times of high and low tides, as well as predicted tidal amplitudes.

Tides in the Flagler County area are semidiurnal: two high tides and two low tides per tidal day (24 hours 50 minutes). Two measures of tidal range are commonly used: the mean tide range is defined as the difference between Mean High Water (MHW) and Mean Low Water (MLW), and represents an average range during the entire lunar cycle (27.3 days); and, the spring tide range is the average semidiurnal range which occurs semimonthly when the moon is new or full, which causes greater tidal amplitudes. The semidiurnal tides around Flagler Beach exhibit a mean tidal range of 3.64 feet.

Presently, the nearest tide station to the project on the ocean side of the island is NOS Station 8720692 (State Road A1A Bridge), located at Matanzas Inlet approximately 17 miles north of Flagler Beach. The nearest tide station on the back-bay side of the barrier island is NOS Station 8720833 (Smith Creek, Flagler Beach), located directly west of Flagler Beach. **Table 2-8** summarizes tidal data from both stations.

**Table 2-8: Tidal Datums**

Tidal Datum	Elevation Relative to MLLW (feet)	
	State Road A1A	Smith Creek
Mean High Water (MHW)	3.80	0.94
North Americal Vertical Datum (NAVD88)	2.28	0.78
Mean Tide Level (MSL)	1.95	0.52
Mean Low Water (MLW)	0.16	0.07
Mean Lower Low Water (MLLW)	0.00	0.00

The primary ocean current in the project area is the Florida Gulf Stream. With the exception of intermittent local reversals, it flows northward. The average annual current velocity is approximately 28 miles per day, varying from an average monthly low of 17 miles per day in November to an average monthly high of approximately 37 miles per day in July. The Gulf Stream lies approximately 60 miles offshore of the project area.

The nearshore currents in the project vicinity are not directly influenced by the Gulf Stream, but may be influenced indirectly via interaction with incident waves. Littoral currents affect the supply and distribution of sediment on the sandy beaches of Flagler County. Longshore currents, induced by oblique wave energy, generally determine the long-term direction and magnitude of littoral transport. Cross-shore currents may have a more short-term impact, but can result in both temporary and permanent erosion. The magnitude of these currents is determined by the wave characteristics, angle of waves from offshore, configuration of the beach, and the nearshore profile. For Flagler County

beaches, the net sediment transport is from north to south. This is due to the dominant wave activity from the northeast during the fall and winter months, particularly northeaster storms.

The influence of the Matanzas Inlet (2.4 miles to the north) and Ponce de Leon Inlet (27 miles to the south) ebb and flood currents on local currents is negligible. In both cases the distance between the inlet and the project area places the project outside the influence of inlet tidal fluctuations.

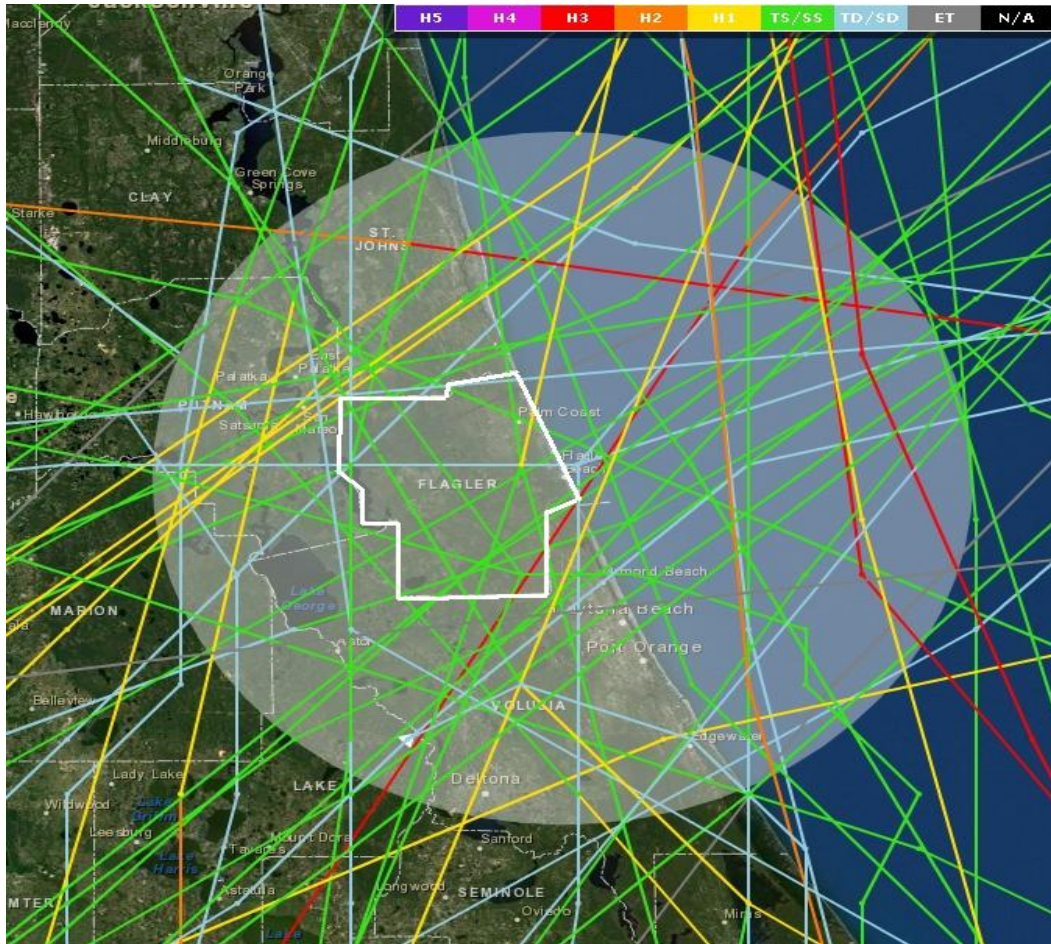
### 2.2.11 Storm Effects

The shoreline of Flagler County is influenced by tropical systems during the summer and fall and by northeasters during the late fall, winter, and spring. Although hurricanes typically generate larger waves and storm surge, northeasters often have a greater impact on the shoreline because of their longer duration and greater frequency.

During intense storm activity, the shoreline is expected to naturally modify its beach profile. Storms erode and transport sediment from the beach into the active zone of storm waves. Once caught in the waves, this sediment is carried along the shore and re-deposited farther down the beach, or is carried offshore and stored temporarily in submerged sand bars. Periodic and unpredictable hurricanes and coastal storms, with their fierce breaking waves and elevated water levels, can change the width and elevation of beaches and accelerate erosion. After storms pass, gentle waves usually return sediment from the sand bars to the beach, which is restored gradually to its natural shape. While the beach profile typically recovers from storm energy as described, extreme storm events may cause sediment to leave the beach system entirely, sweeping it into inlets or far offshore into deep water where waves cannot return it to the beach. This may cause a permanent increase in the rate of shoreline recession.

Flagler County is located in an area of significant hurricane activity. **Figure 2-16** shows historic tracks of hurricanes and tropical storms from 1858 to 2008, as recorded by the National Hurricane Center (NHC) and available from the National Oceanic and Atmospheric Administration (<http://csc.noaa.gov/hurricanes/#>). The shaded circle in the center of this figure indicates a 50-nautical mile radius (encompassing the entire Flagler county shoreline) from the center of the study area. Based on NHC records, 62 hurricanes and tropical storms have passed within this 50-nautical mile radius over the 151-year period of record. Based on this chart, hurricanes and tropical storms pass within 50-nautical miles of the study area approximately every 2.4 years.

The 50-nautical mile radius was chosen for display purposes in **Figure 2-16** because any tropical disturbance passing within this distance, even a weak tropical storm, would be likely to produce some damage along the shoreline. Stronger storms are capable of producing significant damage to the coastline from far greater distances.



**Figure 2-16. Historic storm tracks – Hurricanes and Tropical Storms (1858 – 2008, 50 mile radius).**

In recent years, a number of named storms passing within the 50-nautical mile radius have significantly impacted the project area, including tropical storms Leslie (2000), Eduard (2002), Henri (2003), Charley (2004), Tammy (2005), and Fay (2008). Damages from these storms, as well as from more distant storms causing indirect impacts (Dennis, Floyd, and Irene in 1999; Gabrielle in 2001; Frances and Jeanne in 2004), included substantial erosion and damage from wind, wave, and water action.

Since the study area is exposed to the open ocean from northeast to southeast, as discussed previously, the coastline is vulnerable to wave attack from distant storms as well. Most hurricanes and tropical storms traversing northward through the Atlantic within several hundred miles of the east coast are capable of producing large swells which are capable of causing erosion along the Flagler County shoreline.

## 2.3 Storm Surge

Storm surge is defined as the rise of the ocean surface above its astronomical tide level due to storm forces. Surges occur primarily as a result of atmospheric pressure gradients and surface stresses created by wind blowing over a water surface. Strong onshore winds pile up water near the shoreline, resulting in super-elevated water levels along the coastal region and inland waterways. In addition, the lower atmospheric pressure that accompanies storms also contributes to a rise in water surface elevation. Extremely high wind velocities coupled with low barometric pressures (such as those experienced in tropical storms, hurricanes, and very strong northeasters) can produce very high, damaging water levels. In addition to wind speed, direction and duration, storm surge is also influenced by water depth, length of fetch (distance over water), and frictional characteristics of the nearshore sea bottom. An estimate of storm surge is required for the design of beach fill crest elevations. An increase in water depth may increase the potential for coastal flooding and allow larger storm waves to attack the shore.

The Flagler County study area is susceptible to overtopping from extreme storm surges. Topographic surveys show that much of the island is less than 15 feet in elevation. Elevations of 15 to 20 plus feet occur, but are almost exclusively along the oceanfront dune line. Flagler County Emergency Services (FlaglerEmergency.com) provides hurricane storm-surge and evacuation information to the public. Through this service, estimates indicated that virtually the entire study area would be inundated during a Category 1 hurricane should the storm make direct landfall in the Flagler County vicinity. In the event of a hurricane, only two evacuation routes outside of the barrier island in Flagler County exist: Palm Coast Parkway near the center of the county and the State Road 100 bridge about four miles north of the county line. The only continuous road extending along the length of the barrier island is SR A1A.

Storm surge levels versus frequency of occurrence were obtained from data compiled by the University of Florida for the Florida Department of Transportation (FDOT, 2003). **Table 2- 9** provides peak storm surge heights by return period for three locations in Flagler County: FDEP R-monuments R-0, R-55, and R-99. The storm tide elevations presented in this table include the effects of astronomical high tide and wave setup. Wave setup is the increase in mean water level due to the presence of waves.

**Table 2- 9: Storm Tide Elevations**

Return Period (Years)	Total Storm Tide Level (feet, NAVD88)		
	R-0	R-55	R-99
500	17.2	15.6	14.1
200	14.0	12.8	11.6
100	11.5	10.7	9.6
50	8.7	8.3	7.6
20	5.6	5.3	4.2
10	3.9	3.8	3.6



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### 2.3.1 Sea-Level Rise

Throughout geologic history, global sea level variations, both rises and falls, have occurred. Changes in sea level cause the shoreline to be out of equilibrium and set into motion processes that restore equilibrium; which, in turn, cause the shoreline to erode or accrete. Two processes are predominantly responsible for relative changes in sea level: change in the absolute water level of the oceans and the subsidence or submergence of the land by geologic processes. Based on USACE sea-level rise engineering guidance (Engineering Regulation (ER) 1100-2-8162), the historic rate of sea-level rise for Flagler County is estimated to be 0.0075 feet/year.

### 2.3.2 Effects of Other Shore Protection/Navigation Projects

There are no navigation projects in the vicinity of Flagler County that will affect the study area. Material dredged from the Intracoastal Waterway (IWW) near the Matanzas inlet has been placed on Summer Haven beach in the past. Although it is possible that sand from these activities migrates south to the Marineland reach, a review of the shoreline change data indicates that effects of this migration are negligible.

Potential opportunities exist to implement projects on a regional basis, within the framework of Regional Sediment Management, including sand source investigations, planning, design, coordination, and construction contracts in cooperation with the governmental entities of Flagler County, Volusia County, St. Johns County, Flagler Beach, Ormond Beach, Daytona Beach, and the Florida Inland Navigation District. In particular, beach placement of IWW maintenance dredge material provides an opportunity for an additional sand source, although the channels dredged are quite distant from all but the Marineland reach.

### 2.3.3 Inlet Effects

There are no inlets within Flagler County. The nearest inlets are Matanzas Inlet, 2.4 miles to the north of Flagler County in St. Johns County, and Ponce de Leon Inlet, 27 miles to the south of Flagler County in Volusia County. Matanzas Inlet is a relatively small inlet and is not maintained for navigation. The inlet has a history of migrating to the south, but is now stabilized with the south bridge abutment of the Highway A1A Bridge. Effects of Matanzas Inlet on the Flagler County shorelines to the south have not been quantified, but are expected to be negligible. Ponce de Leon inlet is distant enough and down drift of Flagler County and is therefore not expected to have an impact on the county's beaches.

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## 2.4 Environmental and Historic Resources \*

### 2.4.1 General Environment

Present day Florida occupies a portion of the geological unit known as the Floridian Plateau. This partly submerged platform is nearly 500 miles long, up to 400 miles wide and represents the seaward extension of the coastal plain of Georgia and Florida (Shrober and Obreza, 2008). The submerged portions of the plateau comprise the continental shelf that extends into the ocean to a depth of approximately 300 feet (FDEP SCORP, 2008). Although the plateau has existed for millions of years as alternately dry land or shallow sea, it consists of a core of metamorphic rocks buried beneath a thick layer of sedimentary rock composed mostly of limestone (FDEP SCORP, 2008). Portions of the plateau have been exposed over time as dry land due to periods of relative drops in sea level. Each exposure has left behind a wide variety of hard mineral deposits. The movement of these deposits has formed present day sandy beaches, offshore bars, and barrier islands (Randazzo and Jones, 1997).

As previously discussed, wind and water are the primary environmental forces that shape the morphology of beach dunes present at Flagler County. Likewise, these processes also directly influence the ecology of this land form (Myers and Ewel, 1990). Vegetation on the dune face is regularly exposed to salt spray and sand burial from onshore winds blowing across the saltwater and open sandy beach (FNAI, 2010). Plants on the upper beach are subject to these stresses plus occasional inundation by high seasonal or storm tides and periodic destruction by waves. The vegetation of this community is adapted to either withstand these stresses or to rapidly re-colonize following destruction (Myers and Ewel, 1990). Storm waves may erode the seaward face of the dune, moving sand offshore to form underwater bars and barrier islands, or break through the dune moving sand inland as overwash (FNAI, 2010). New colonization by pioneer species is initially haphazard, but gradually becomes organized into a sorted dune face with an upper beach zone as waves build the beach back up. Likewise, wind moves the sand inland to form a new dune ridge (FNAI, 2010). Upon this level of maturity, the ridge blocks salt spray and plant cover inhibits sand movement. Inland herbaceous species become replaced by woody species indicative of an intermediate succession (Myers and Ewel, 1990). The investigated borrow areas include part of the Korona Ridge Field geomorphologic unit (Area 2) and part of the Flagler Sand Wave geomorphologic unit (Area 3).

### 2.4.2 Vegetation

Beach dune along the Flagler County coast is a predominantly herbaceous plant community consisting of wide-ranging coastal species on the upper beach and foredune (first dune above the beach). This community is primarily built by sea oats (*Uniola paniculata*), whose rhizomes and stems trap sand grains blown from the beach. This process builds the dune by growing upward to keep pace with sand burial (Taylor, 1998). Other grasses that can tolerate sand burial include bitter panic grass (*Panicum amarum*), and saltmeadow cordgrass (*Spartina patens*) (Myers and Ewel, 1990).

Camphorweed (*Hetrotheca subaxillaris*) often grows with sea oats where sand burial is absent or moderate within a disturbed community. Seacoast marshelder (*Iva imbricata*), is a succulent shrub that is found at the seaward base of the foredune. These dominant species may also occupy the face left from dune disturbance due to storm erosion where sand is not yet stabilized by vegetation (Myers and Ewel, 1990). The upper beach area seaward of the foredune is a less stable habitat, frequently disturbed by high spring or storm tides, and is continually re-colonized by annual species such as sea rocket (*Cakile lanceolata.*), crested saltbush (*Atriplex cristata*), and Dixie sandmat (*Chamaesyce bombensis*), or by trailing species like railroad vine (*Ipomoea pes-caprae*), beach morning glory (*Ipomoea imperati*), the salt-tolerant grasses seashore paspalum (*Paspalum vaginatum*), and seashore dropseed (*Sporobolus virginicus*) (Taylor, 1998). Non-dominant species found in the beach dune community include dune sunflower (*Helianthus debilis*), sand spur (*Cenchrus spp.*), and shoreline seapurslane (*Sesuvium portulacastrum*); see **Figure 2-17** (FNAI, 2010).



**Figure 2-17: Typical foredune vegetation of beach morning glory and shoreline seapurslane.**

#### 2.4.3 Threatened and Endangered Species

Several listed protected species under the Endangered Species Act of 1973 (ESA) are found along the coastal area of Flagler County. These include the federally-threatened West Indian manatees (*Trichechus manatus latirostris*) that primarily use the Atlantic Ocean and associated inlet estuaries to migrate and forage for food. As there are no inlets in the study area, manatee would not be likely found in the study area. This habitat type is outside of the study area and is excluded from this discussion. Marine turtles, including loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback

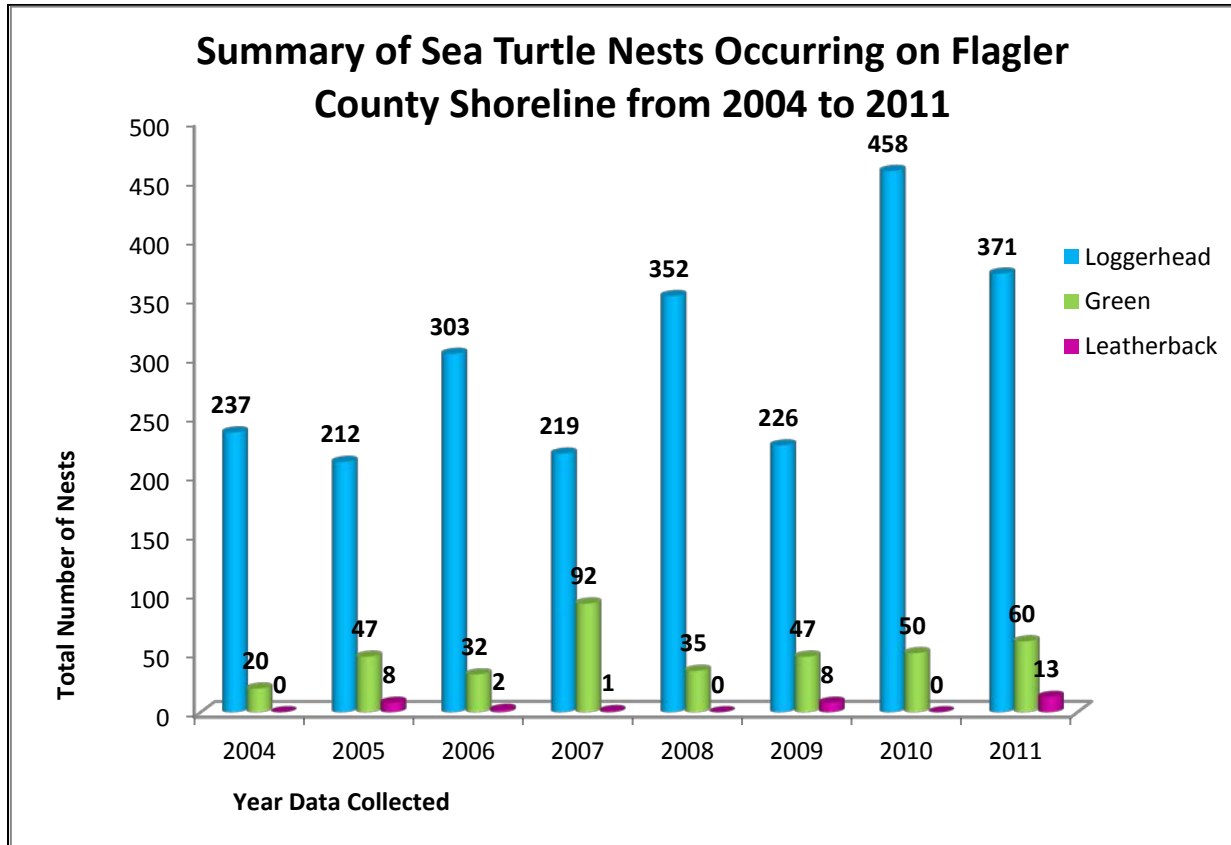
(*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and Kemp's ridley (*Lepidochelys kempii*), are known to occur within the study area. All of these species are federally endangered except the loggerhead, which is classified as threatened. The loggerhead, green, and leatherback are the only sea turtles known to regularly nest on beaches within the project area (FWC FWRI website, 2012). To date, no critical habitat has been designated for the loggerhead sea turtle; however, FWS recently published a proposal to designate critical habitat throughout the southeast U.S. for loggerhead sea turtles that was published on March 25, 2013 (FR Vol.78 No. 57 18000 - 18082). One of the proposed "recovery units" (LOGG-T-FL-04) includes the entire coastline of Flagler County, starting at Matanzas Inlet and ending at the south boundary of Peninsula State Park in Volusia County. Sea turtles may also utilize the proposed borrow area offshore, although no survey data has been collected to assess this usage. The proposed loggerhead turtle critical habitat includes offshore Florida as potential breeding habitat, which could include the borrow area located 7 miles offshore (NMFS Website press release, July, 2013).

Five whale species listed as federally endangered may occur in the Atlantic Ocean along the Flagler County coastline during certain times of the year (National Marine Fisheries Service [NMFS] website, 2012). These species include the North Atlantic right whale (*Eubalaena glacialis*), sei whale (*Balaenoptera borealis*), fin whale (*B. physalus*), humpback whale (*Megaptera novaeangliae*), and sperm whale (*Physeter macrocephalus*). Only the North Atlantic right whale and the humpback whale have been sighted along coastal Flagler County. Smalltooth sawfish are unlikely to be present in the nearshore along the Flagler County shoreline based on recent abundance and distribution data, although historically, they have been known to occur in the Atlantic in the Everglades region of south Florida and the Gulf of Mexico (NMFS website August, 2013). Areas of the Flagler County coast are also supportive of piping plover, (*Charadrius alexandrinus*). Although no FWS-designated critical habitat is located within Flagler County, several piping plover were observed on the beach associated with the Gamble Rodgers Memorial State Recreation Area, around FDEP monument R-95.

### Sea Turtle

#### Sea Turtle Nesting Habitat

Sea turtle statistical data were acquired from the Florida Fish and Wildlife Conservation Commission (FWC) for three sea turtle species known to occur within the study area, including the critically eroded area that encompasses a total of 5.1 miles of potential sea turtle habitat. Sea turtle nests and false crawl trails were observed within the entire study area, and were evaluated from data collected between 2004 and 2011. Of the three species utilizing the study area, nests of loggerhead turtle (*Caretta caretta*) have the highest presence, followed by those of green turtle (*Chelonia mydas*). Leatherback turtle (*Dermochelys coriacea*) nests were the least observed, see **Figure 2-18**. Currently, the NMFS has proposed designation of critical habitat for loggerhead turtles along the Florida coastline. The outcome of this designation is pending.



Data Source: Florida Fish and Wildlife Conservation Commission

**Figure 2-18: Flagler County Nesting Sea Turtle History**

The Florida Fish and Wildlife Conservation Commission (FWC) data-set covers the period from 2004 to 2011, including the years of significant hurricanes and extreme storms from 2004 to 2006. Also, Tropical Storm Fay struck the coast along mid Flagler Beach in 2008, which extensively damaged sea turtle nests at that time. Similarly, several unnamed storms caused considerable impact to sea turtle nests during this period.

The species of sea turtles that occur in the Flagler County study area are intermittently migratory throughout their life cycles (NMFS factsheet, 2010). The nearshore and inshore waters may be used by juveniles as post-hatchling developmental or foraging habitat, but adults migrate seasonally between summer and winter habitats (Lohmann et al, 1999). Often, loggerhead and green turtles return to specific widely dispersed feeding grounds that are sometimes located hundreds or thousands of kilometers from their nesting sites (Limpus et al, 1992). Little information is available regarding how adult turtles navigate over long distances or how they relocate in the natal region for mating and nesting (Lohmann et al, 1999). Although some individuals may be present at their natal areas at any given time, abundance is likely to be greater in summer than winter within the Flagler County coastal reaches.

A 2008 FWS report determined that several beaches within the study area contain mostly unsuitable habitat for nesting sea turtles in the presence of various revetments and armor structures. These structures have the potential to modify behavior of nesting females resulting in false crawls, nesting in sub-optimal habitat, a decrease in nesting activity, and increased entrapment or mortality of nesting turtles and hatchlings, in addition to washout or inundation of eggs laid seaward of armor structures (FWS/NMFS, 2008). A 2002 report by FDOT also found that existing beaches along much of Flagler County's coast is unsuitable for sea turtle usage, concluding that the beaches may be too narrow for successful nesting. The FDOT report further determined it was highly probable that construction of SR A1A and development of residential and commercial structures have contributed to the loss of beach substrate and dune habitat.

Nesting data provided by FWC could not be correlated with exact spatial locations as GPS data are not collected during the nest monitoring event. Therefore, we were not able to determine any established trends, such as how many nests occur within a specific critically eroded area, or which of the three species may dominate a particular reach. Although no nest-specific location data is available, density of nests per particular reach within the study area was determined using the FWC data. High density is described as nests occurring in close proximity to others; conversely, low density is when nests occur with greater distance between them.

Of the three identified sea turtle species nesting within Flagler County, loggerhead turtles were found to have the highest density of nests throughout all reaches, see **Table 2-10**. Similar nesting data is presented in **Table 2-11** for green turtles, and **Table 2-12** for leatherback turtles. For all tables, reach length is provided for each area in both miles and feet. The density is stated in terms of the distance between each nest within the reach for a given year. For example, a reach that has several nests occurring within its limits will have lower footage or mileage; in contrast, the greater the footage (or mileage), the lesser the number of nests that occur within the reach for a given year.

The NMFS and FWS convened a biological review team (BRT) in February 2008 which determined that a distinct population segment (DPS) exists for loggerhead sea turtles within the Northwest Atlantic region based on genetic evidence, demographic data, and other criteria (Conant et al, 2009). Research indicates that the majority of nesting aggregations for the Northwest Atlantic loggerhead DPS is in South Florida (FWS website, 2012). The northern beaches of Flagler County, including Marineland and Washington Oaks State Park, are found to have a healthy density of loggerhead turtle nests, whereas the mid sections of the county's coastline are less utilized for nesting habitat. The extreme southern end of the county, including the Gamble Rodgers Memorial State Recreational Area, was found to have the highest density of loggerhead nests along the beach. The years 2004 to 2006 experienced reduced nesting due to extreme weather events from hurricanes and other storms. The year 2010 appears to have been the peak season for nesting loggerhead turtles in Flagler County.

**Table 2-10: Flagler County Loggerhead Sea Turtle Nesting Density Data Summary**

Year	Marineland R-1 to R-12		Washington Oaks State Park R-12 to R-16		North Flagler County Beaches R-16 to R-35		South Flagler County Beaches R-35 to R-67		Flagler Beach R-67 to R-95		Gamble Rodgers Memorial SRA R-95 to R-101	
	Miles	Feet	Mile	Feet	Mile	Feet	Miles	Feet	Miles	Feet	Miles	Feet
	2.05	10824.00	0.90	4752.00	3.31	17476.80	5.70	30096.00	5.01	26452.81	1.25	6600.00
	1 Nest		1 Nest		1 Nest		1 Nest		1 Nest		1 Nest	
	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet
2004	0.44	2534.40	0.10	528.00	0.17	897.60	0.07	381.00	0.06	331.00	0.04	220.00
2005	0.26	1353.00	0.45	2376.00	0.08	426.30	0.06	338.20	0.08	426.70	0.13	660.00
2006	0.22	1202.70	0.30	1584.00	0.07	388.40	0.06	327.10	0.08	426.70	0.14	733.30
2007	1.03	5412.00	0.02	1188.00	0.06	317.80	0.06	327.10	0.09	456.10	0.16	825.00
2008	0.14	721.60	0.30	1584.00	0.05	286.50	0.04	212.00	0.06	334.42	0.06	161.00
2009	0.26	1353.00	0.08	396.00	0.07	388.40	0.06	344.40	0.12	630.00	0.04	227.60
2010	0.26	135.30	0.11	594.00	0.02	129.40	0.03	163.60	0.05	278.50	0.04	235.70
2011	0.19	984.00	0.08	396.00	0.04	201.00	0.04	185.80	0.07	367.40	0.05	244.40

**Table 2-11: Flagler County Green Sea Turtle Nesting Density Data Summary**

Year	Marineland R-1 to R-12		Washington Oaks State Park R-12 to R-16		North Flagler County Beaches R-16 to R-35		South Flagler County Beaches R-35 to R-67		Flagler Beach R-67 to R-95		Gamble Rodgers Memorial SRA R-95 to R-101	
	Miles	Feet	Mile	Feet	Mile	Feet	Miles	Feet	Miles	Feet	Miles	Feet
	2.05	10824.00	0.90	4752.00	3.31	17476.80	5.70	30096.00	5.01	26452.81	1.25	6600.00
	1 Nest		1 Nest		1 Nest		1 Nest		1 Nest		1 Nest	
	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet
2004	0.68	3608.00	0.00	0.00	0.41	2184.60	0.63	3344.00	0.00	0.00	0.00	0.00
2005	0.41	2164.80	0.45	2376.00	0.25	1344.37	0.30	1584.00	0.63	3306.60	0.00	0.00
2006	0.00	0.00	0.30	1584.00	0.30	1588.80	0.71	3762.00	2.505	13226.40	0.16	825.00
2007	2.05	10824.00	0.23	1188.00	0.17	873.84	0.11	578.77	0.36	1889.49	1.25	6600.00
2008	0.34	1804.00	0.15	792.00	0.30	1588.80	0.63	3344.00	5.01	26452.80	0.63	3300.00
2009	2.05	10824.00	0.30	1584.00	0.28	1456.40	0.22	1157.54	1.67	8817.60	0.63	3300.00
2010	2.05	10824.00	0.30	1584.00	0.25	1344.37	0.23	1203.84	1.00	5290.56	0.42	2200.00
2011	0.41	2164.80	0.18	950.40	0.33	1747.68	0.20	1037.79	0.56	2939.20	0.63	3300.00

**Table 2-12: Flagler County Leatherback Sea Turtle Nesting Density Data Summary**

Year	Marineland R-1 to R-12		Washington Oaks State Park R-12 to R-16		North Flagler County Beaches R-16 to R-35		South Flagler County Beaches R-35 to R-67		Flagler Beach R-67 to R-95		Gamble Rodgers Memorial SRA R-95 to R-101		
	Reach Length	Miles	Feet	Mile	Feet	Mile	Feet	Miles	Feet	Miles	Feet	Miles	Feet
		2.05	10824.00	0.90	4752.00	3.31	17476.80	5.70	30096.00	5.01	26452.81	1.25	6600.00
		1 Nest		1 Nest		1 Nest		1 Nest		1 Nest		1 Nest	
		Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet	Per Mile	Per Feet
2004		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005		0.00	0.00	0.00	0.00	1.66	8738.40	1.90	10032.00	1.67	8817.60	0.00	0.00
2006		0.00	0.00	0.00	0.00	0.00	0.00	5.70	30096.00	0	0.00	1.25	6600.00
2007		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25	6600.00
2008		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009		0.00	0.00	0.00	0.00	3.31	17476.80	1.14	6019.20	2.51	13226.40	0.00	0.00
2010		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011		2.05	10824.00	0.00	0.00	0.66	3495.36	1.43	7524.00	1.67	8817.60	0.00	0.00

Data Source: Florida Fish and Wildlife Conservation Commission Florida Wildlife Research Institute



Regionally, green sea turtles have the highest nesting densities located along the southeast Florida coast from Brevard to Palm Beach counties (FWC website, 2012). Locally, nesting green sea turtles were found more often on the beaches along the southern end of the Flagler County coast. The density of green sea turtle nests per reach distance was considerably lower overall than that of loggerhead turtles.

According to the FWC, Florida is the only state in the continental U.S. where leatherback turtles regularly nest (FWC website, 2012). Most of this nesting on the Atlantic coast occurs in Palm Beach County, or around 50% (FWC website, 2012). Locally, leatherback turtle nests were least frequently sighted, occurring along the Flagler County coast in the southern reaches from FDEP monument R-67 to R-95. The peak year for nesting by both green and leatherback sea turtles was 2007.

Anecdotal observations of sea turtle nests along various reaches of the study area were recorded during a site visit by a USACE biologist on 2 August 2011. Informal data collected from representative sites within each reach of the study area show a similar trend of nests present along the shoreline having the least amount of erosional damage or armoring. At the north end along Marineland Beach, 12 sea turtles nests were observed between FDEP monuments R-2 to R-4. Another 13 nests were present at Washington Oaks State Park, R-14 to R-15. However, no nests were observed near the Flagler Beach Pier, R-79, where dune erosion, revetment, and armor structure are present. At the southern reach of Flagler Beach from R-90 to R-100, 29 nests were observed where a wider, undeveloped beach is located. All of the nests were located in the upper beach area at the toe of the dune slope containing a backdrop of natural sand and vegetation, see **Figure 2-19**. No nests were observed along the sections of shoreline containing armoring or revetment.



**Figure 2-19: Typical section along Flagler Beach where sea turtle nesting occurs within a vegetated natural area of upper dune. The species of sea turtle using this nest most likely was a loggerhead, based on the tracks.**

#### Sea Turtle Mortality

The Florida Wildlife Research Institute (FWRI) is an arm of the FWC that conducts research and evaluation of sea turtle mortality throughout the state using the Florida Sea Turtle Stranding and Salvage Network (FLSTSSN).

FWC reports of Flagler County for the years 2010 and 2011 indicated 21 loggerhead, 19 green, 3 Kemps ridley, and 3 unknown species of sea turtles were found stranded. The primary threat to sea turtles in Flagler County is beachfront lighting. Ocean front artificial lighting that is visible from the beach can attract hatchling turtles away from the ocean to their deaths.

#### North Atlantic Right Whale

The North Atlantic right whale (*Eubalaena glacialis*) is a federally endangered species protected under the ESA with jurisdiction by NMFS, and also the Marine Mammal Protection Act of 1972 (NMFS website, 2012). They are among the most imperiled whale species in the world (NMFS website, 2012). Right whales are a marine mammal weighing up to 70 tons. They can grow up to 55 feet long with a stocky, black body and no dorsal fin, but have callosities (raised patches of rough skin) on the head region (NMFS website, 2012). They can live up to 50 years or possibly longer, although more research is needed to determine their true life span (NMFS website, 2012). Their mouths contain baleen (long strips of dangling hardened protein material) which they use to skim prey consisting of zooplankton and small invertebrates, such as krill, pteropods and copepods (NMFS website, 2012). Right whales initially give birth at the

age of nine or ten years after a year-long gestation. The interval between births averages three to six years. When born, calves are typically 13 to 15 feet long and weigh approximately 3,000 pounds (NMFS website, 2012).

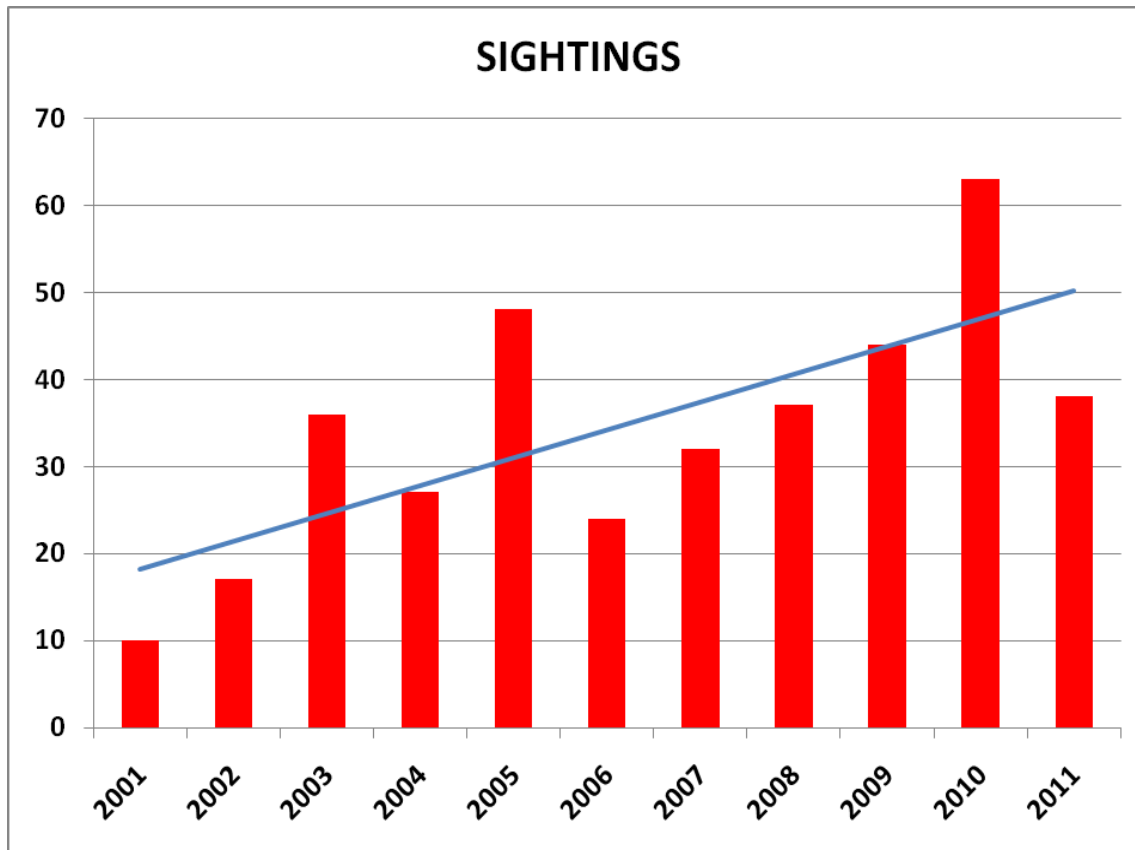
A population of right whales in the western North Atlantic range during wintering and calving season in warmer coastal waters off the southeastern United States. They return north in early spring to their summer feeding and nursery grounds in New England oceanic waters and the Bay of Fundy (NMFS website, 2012). An identified high use area is adjacent to Florida and Georgia, which includes the entire Flagler County coastal zone from the shoreline to five miles offshore. This usage is based upon key habitat criteria for wintering and calving, which led to a “Critical Habitat” designation by NMFS, designated pursuant to the ESA. The wintering and calving period of right whale activity in the southeastern United States, particularly the Florida coast, starts around early to mid December, and ends in late March, weather condition dependent.

Two main threats to right whales are ship strikes and fishing gear entanglement. Vessel collision has caused a clear trend of declining population that was first noticed in the late 1990s (NMFS website, 2012). This trend indicated a high probability that right whales could go extinct within 200 years if the mortality rate from ship strike was not curtailed (NMFS website, 2012). Their slow movement and time spent at the water surface in nearshore conditions make them highly vulnerable to human activities, especially collision with vessels (NMFS website, 2012). This finding resulted in policy adoption, such as the NMFS speed restriction zones, as well as technological advancement of the Mandatory Ship Reporting System (MSRS) (NMFS Recovery Plan, 2004).

The other leading source of human-induced mortality is entanglement in fixed fishing gear which can accidentally capture right whales in long lines used for crab traps and other sea life. To illustrate this problem, on December 19, 2012 a dead right whale carcass was found washed up on Flagler Beach just south of Varn Park (within the study area but outside of the project area). The whale was a juvenile male that was reported to have a large rope wrapped around its tail, although the cause of death is still pending from a necropsy being conducted by NMFS. In response to this growing concern, NMFS recently revised its recovery plan for the North Atlantic right whale in 2013. While research efforts are underway to address efficient and humane methods for detanglement of whales from fishing gear, NMFS is proactively pursuing regulatory requirements for commercial fishing gear to prevent entanglement (NMFS Recovery Plan, 2004).

The Marineland Right Whale Project, a volunteer-based citizen group in association with the Associated Scientists at Woods Hole, Inc (ASWH), has conducted annual data collection based on sightings from stationary sites, mobile sites, and most recently, a small aircraft-mounted camera known as “air cam”. The group enlists local citizens to report and record daily sightings of whales that occur along the coast from St. Augustine in St. Johns County to the Ponce Inlet in Volusia County. Based on the data collected

through this research effort, a trend of right whale sightings is presented in **Figure 2-20**. After five years of an upward trend, there was a decrease in 2011.



Source: Associated Scientist at Woods Hole, Inc Marineland Right Whale Project

**Figure 2-20:** Marineland Right Whale Project Data. The number of total whale sightings per year, including a simple linear trend line.

### Humpback Whale

Humpback whales (*Megaptera novaeangliae*), whose name means "big-winged New Englander," typically reach lengths of 14.6 to 15.2 m and weights of 31 to 41 metric tons. Females are usually slightly larger than males and an exceptional individual may be up to 18.9 m in length and weigh 48 metric tons. For their length, they tend to be greater in girth than the other baleen type whales. Other differences of the humpback whale include lack of a median head ridge, enormous flippers, and the presence of numerous knobby structures, or "dermal tubercles," about the dorsal surface of the snout, chin, and mandible (NMFS website, 2012). The number and location of these head tubercles vary between individuals; each containing a sensory hair. The throat pleats are fewer and spaced wider apart than is typical for baleen whales. Coloration is black overall with irregular white markings on the throat, sides, and abdomen. Some individuals may have white undersides or white patterns dorsally. The flippers are long (up to 4.6 m) and narrow; they are typically white below but range from black to patterns

of black and white dorsally, or occasionally fully white (NMFS website, 2012). The tail flukes are broad, serrated on the free edge, and black above with black and white coloration ventrally. Distinctive tail flukes may serve to identify individual humpback whales. The humpback gestation period is approximately 11 months. A 10 to 15-foot baby humpback may nurse as long as a year, adding up to 15 feet in length each month. Sexual maturity is reached at 2 to 5 years, when the young whales measure about 12 meters in length. Physical maturity is reached at 12 to 15 years of age. Females breed only every other year which adds speculation to why they may be reaching extinction (NMFS website, 2012).

Humpbacks typically submerge for several minutes at a time with occasional dives up to 30 minutes. The blow may be up to 10 feet high and is rather bushy. When diving, humpbacks arch the back steeply, thus the common name, and routinely raise their flukes when they dive. The flukes rarely show in shallow dives but when a deep dive is accomplished the flukes may be lifted well above the water's surface. They are known for spectacular leaps and long, white side flippers and often congregate in groups of 20 to 30 up to 100 to 200 individuals.

Humpback whales migrate along the Gulf Stream in January off the east coast of Florida. Humpbacks are capable of travelling at 5 mph averaging only 1 mph on long journeys to rest and socialize along the way (NMFS website, 2012). They migrate through the same waters, though earlier and later than North American right whales, on their way to and from their Dominican Republic birthing grounds. After breeding season, they return to a newly-designated marine sanctuary off Massachusetts in the spring to feed on slender, five-inch-long fish called sand lance. They feed only in summer. During the winter and breeding, they live off their accumulated fat stores (NMFS website, 2012).

Through 2013, there are on average about two dozen reports of humpback whales from Sapelo Island, Georgia, to Fort Lauderdale, Florida. Researchers at FWC believe that this number of reports is not unusual for this time and location (Marineland Right Whale Project, 2013).

### Piping Plover

Piping plover (*Charadrius melodus*) are buff colored, small shorebirds with short black bills and yellow legs (in wintering plumage) (FWS website, 2012). They became a protected species under the ESA in 1986 and are classified as threatened in their southern migration and wintering range, and as endangered in their northern nesting and breeding range, (FWS Recovery Plan, 2009). They migrate from their nesting grounds in northern climates (Great Lakes, southern Canada, and upper Midwest), to winter along the southeastern coastal areas including Florida's Atlantic and Gulf coasts. In Florida, the number of piping plover recorded during the 2006 International Piping Plover Breeding Census (USGS, 2009) totaled 454, with 133 occurring on the Atlantic coast and 321 found on the Gulf coast. A total of 69 sites along 239 miles (384

kilometers) on the Atlantic coast were surveyed, whereas 117 sites along 522 miles (840 kilometers) were surveyed on the Gulf coast.

The wintering habitat desired by piping plover consists of open sandy beach with access to the swash zone or intertidal pools at low tide that provide foraging of invertebrate food sources such as worms and tiny crustaceans. They also utilize the upper beach with short dunes and wrack-line debris to hunker down during wind or storm events (FWS website, 2012). Significant threats to piping plover include habitat loss from coastal development; disturbance by human foot and vehicular traffic; harassment by domesticated pets, feral cats, and predators such as raccoons, skunks and foxes; and finally, storm events.

In Flagler County, two sites have been identified in previous years for infrequent sightings of piping plover. These include the beach from Marineland to Washington Oaks State Park (FDEP Monument R-12 to R16), and Gamble Rodgers Memorial State Recreation Area, (R-95 – R-98) (USGS, 2009); see **Figure 2-30** for their locations along the Flagler County coastline. Although none of the Flagler County coastline is within a FWS-designated Piping Plover Critical Habitat Unit, they were sighted by a USACE biologist in the Gamble Rodgers Memorial State Recreation Area as recently as August, 2011, see **Figure 2-21**. Typical migration of piping plover to wintering habitat occurs during mid-July to late October, and they may remain until late March or April per year until returning to their northern breeding habitat (FWS website, 2012).



**Figure 2-21: Wintering piping plover at Gamble Rodgers Memorial State Recreation Area. Three observed individuals (circled in red) by USACE biologist in August, 2011. Note the wrack line, a desirable habitat component, on the upper beach.**

### Red Knot

Red knot (*Caladris canutus* spp *rufus*) is proposed under the ESA as a candidate bird species by the northeast FWS Region 5 (FWS 2011). The current FWS species assessment and listing priority assignment (May 2011) states that the species wintering habitat range includes the eastern coastline of Florida where wintering red knots forage along sandy beaches, tidal mudflats, salt marshes, and peat banks, as well as mangrove and brackish lagoons. Of these habitat types, only sandy beaches are found in Flagler County, which are moderately degraded. Although the most recent report of a red knot sighting was in 2007 at Gamble Rodgers Memorial State Recreation Area (eBirds database website 2013), the likelihood of red knot occurring on the beaches throughout Flagler County is very low.

### Smalltooth Sawfish

The smalltooth sawfish (*Pristis pectinata*) is currently listed as endangered under the ESA by NMFS (50 CFR 224). In 2003, it was the first marine fish species in U.S. waters added to the ESA listing. Although smalltooth sawfish once ranged throughout U.S. coastal waters along the southeastern Atlantic and northern Gulf of Mexico, its known primary range is now reduced to the coastal waters near Everglades National Park and the Charlotte Harbor Estuary in extreme southern Florida (NMFS website August, 2013). Sightings are very rare. No designated critical habitat occurs along the Flagler County shoreline within the study area. Smalltooth sawfish typically inhabit shallow waters (depths up to 20 feet) near the mouths of rivers in estuarine lagoons over sandy or muddy substrates; likewise, they may also be found in deeper waters (greater than 50 feet) along the continental shelf (NMFS Website August 2013). The current 1997 South Atlantic Regional Biological Opinion (SARBO) does not include smalltooth sawfish. Sawtooth sawfish are unlikely to be present in the nearshore along Flagler County shoreline.

#### 2.4.4 Hardbottoms \*

There are extensive nearshore outcroppings of coquina rock (Anastasia formation) in the sub- and intertidal zones of many beaches in Flagler County (FWCC, 2008). Surveys completed by USACE in 2012 indicate that most nearshore outcroppings exist north of R-50 in the study area. These areas are ephemeral, meaning that they are periodically covered and uncovered by natural sediment movement, and require mapping to determine the exact locations of the rock. Nearshore hardbottom features affect wave refraction and provide a major factor in maintaining the overall shoreline curvature (FDOT, 2002). These exposed rock surfaces also provide important habitat in the nearshore environment. Nearshore hardbottom reefs serve as settlement habitats for immigrating sub-adults of fish and invertebrates, or as intermediate nursery habitats for juveniles emigrating out of nearby inlets (Vare 1991). **Table 2-13** provides the locations of known outcropping/hardbottoms.

**Table 2-13: Flagler County Nearshore Location of Rock Outcroppings/Hardbottoms**

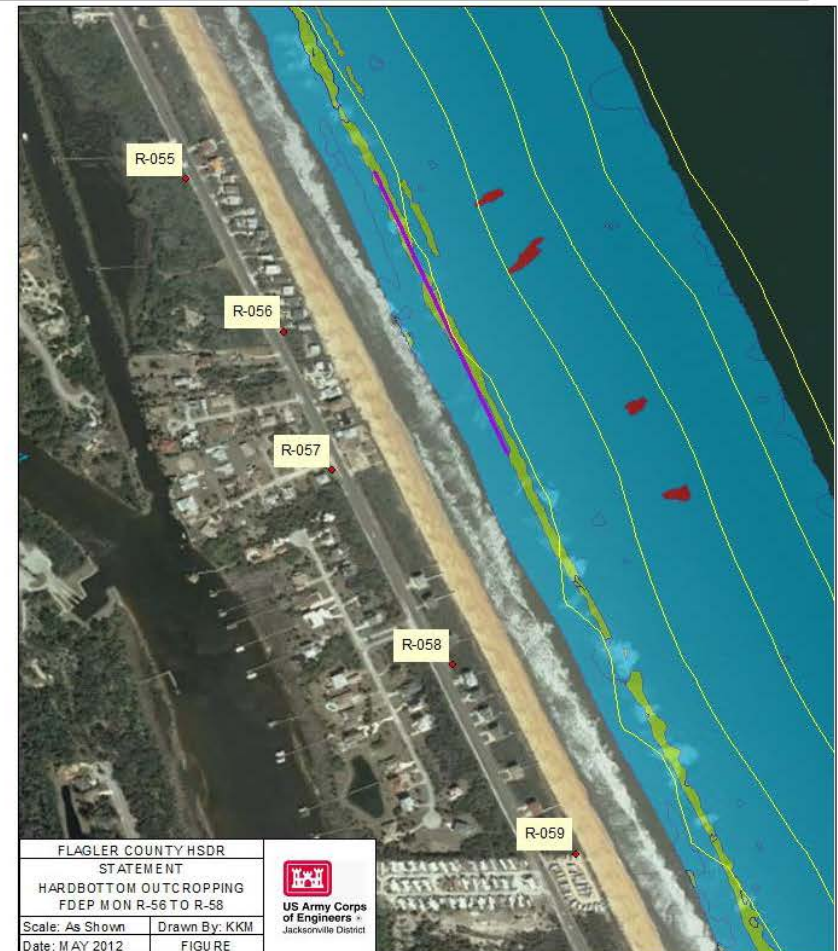
Location/ Study Reach	Range Location	Major Feature(s)
Within the southern portion of Marineland study reach	R-3 to R-16	Pronounced outcrops of beach rock
Outside of study area (The Hammocks)	R-20 to R-43.	Patchy beach rock outcrops
Southern portion of the Beverly Beach study reach, and the north end of the Flagler Beach study reach	R-65 to R-71	Significant rock outcrops
Flagler Beach study reach	R-79 to R-92	Significant rock outcrops
Mainly north of R-50 in Marineland and The Hammocks.	R-1 to R-50	Nearshore hard-bottom outcrops

Source: DEP (1999), Flagler County, Shoreline Change Rate Estimates. Information updated as a result of 2012 Corps nearshore hard-bottom surveys.

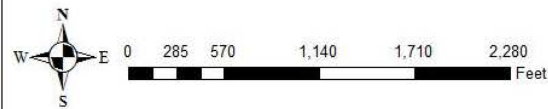
As the feasibility study progressed, the shoreline from R-50 to R-100 became the focus for a potential project. In 2011, a sub-surface survey consisting of sidescan sonar was conducted by Dial Cordy and Associates, Inc. (DCA), to map the locations of hardbottom within the nearshore adjacent to Flagler County. The specific survey area included the southern half of the county, from FDEP monument R-50 to R-100. As shown in **Figure 2-22** through **Figure 2-25**, the hardbottom features are predominantly linear, laying perpendicular to the shoreline. Their locations in the nearshore average between 800 to 1000 feet from the MHW, and they occur most often in clusters, or occasionally alone. The distance of the gaps between the clusters averages between 1000 to 2000 feet. A majority of the known locations are within sand substrate, although a considerable number occur in sand-shell hash that is present in the immediate submerged shoreline between 5 to 10 feet of depth. The hardbottom features range in size from small (mean length of 35 to 45 feet), medium (mean length of 80 to 100 feet), and large (mean length of 200 to 400 feet). The hardbottom reefs were typically found in water depths between 15 to 25 feet. Additional survey of the same area was conducted by the USACE Jacksonville District Hydrographic Survey Section, Operations Division during the summer of 2012. This survey found no hardbottoms in the area. A copy of both the Dial Cordy and Associates, Inc. survey report and the USACE survey report including methodologies and results is in **Appendix F**. The difference in findings is discussed in this section.

A side scan survey was also performed the USACE Jacksonville District Hydrographic Survey Section for Borrow Areas 2A, 2B, and 2C. No targets of interest or hardbottom were found in any of the areas. There were sand waves and sand ridges apparent in all three areas. The report from this survey can be found in **Appendix F**.

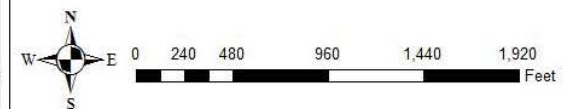




- ◆ FDEP Monument
- Sand
- Sand with shell hash
- Exposed or near-surface rock
- Coastal Critical Erosion
- 5-Foot Contours

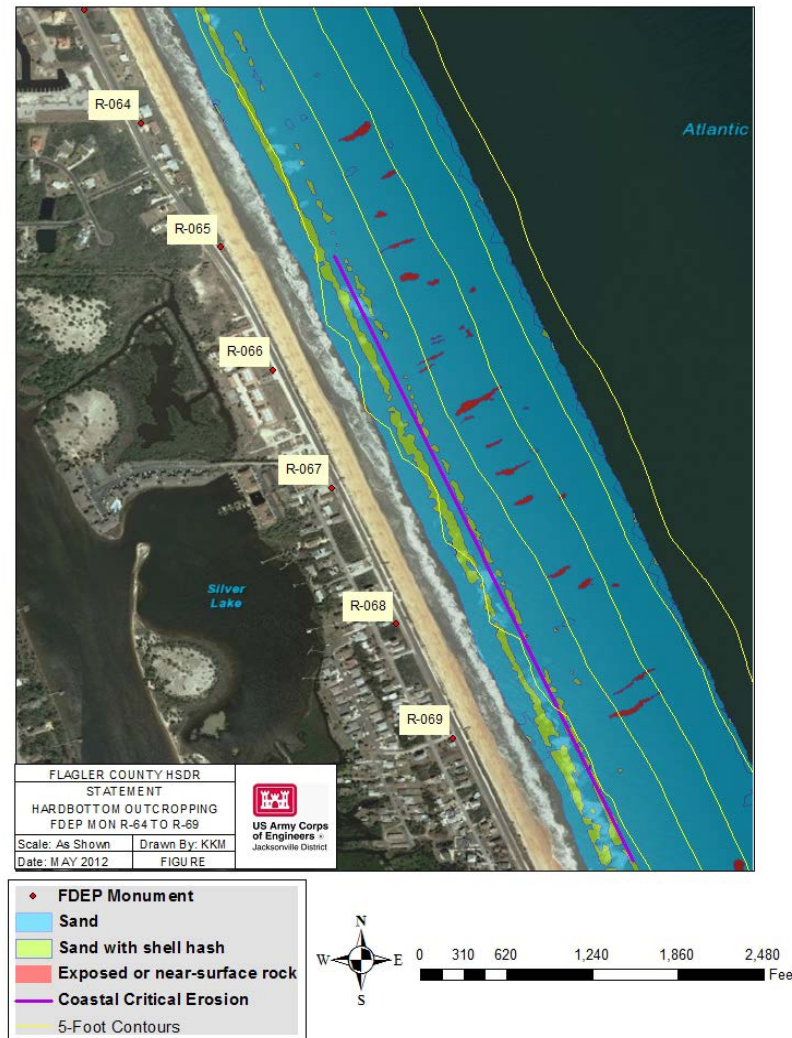
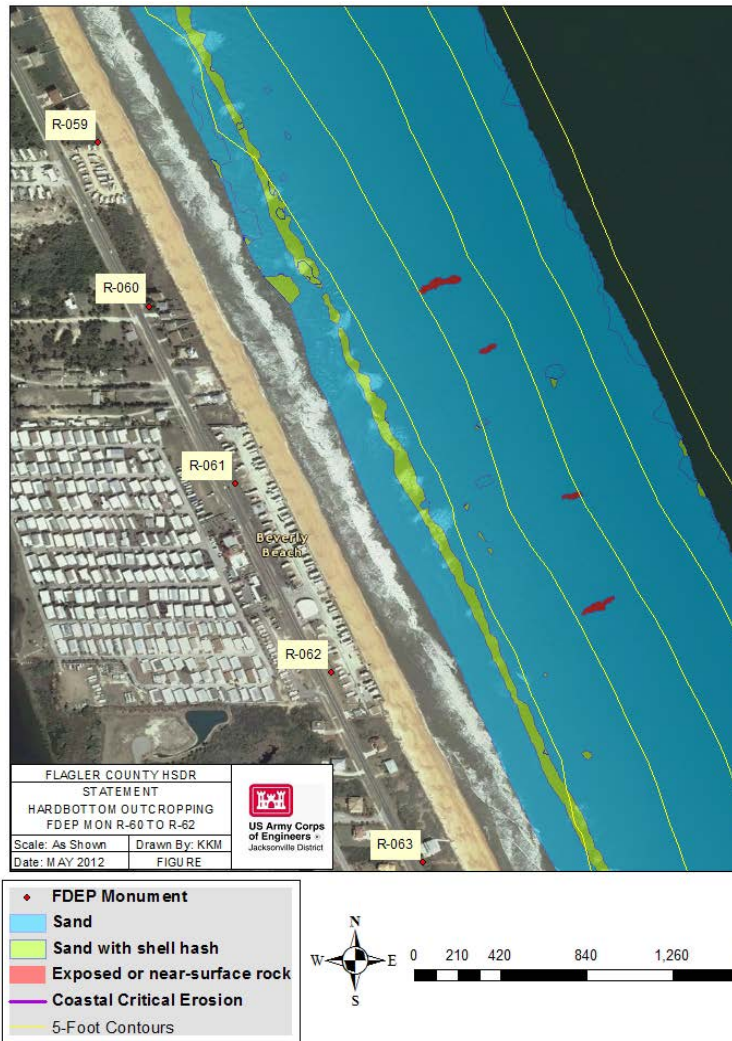


- ◆ FDEP Monument
- Sand
- Sand with shell hash
- Exposed or near-surface rock
- Coastal Critical Erosion
- 5-Foot Contours



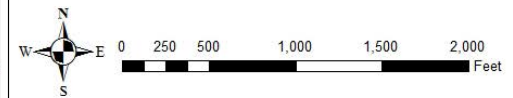
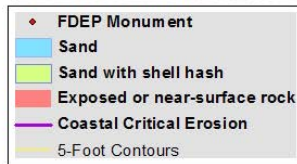
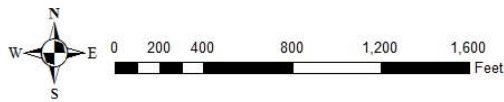
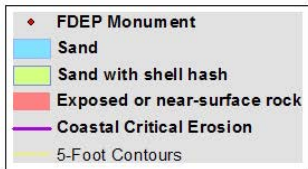
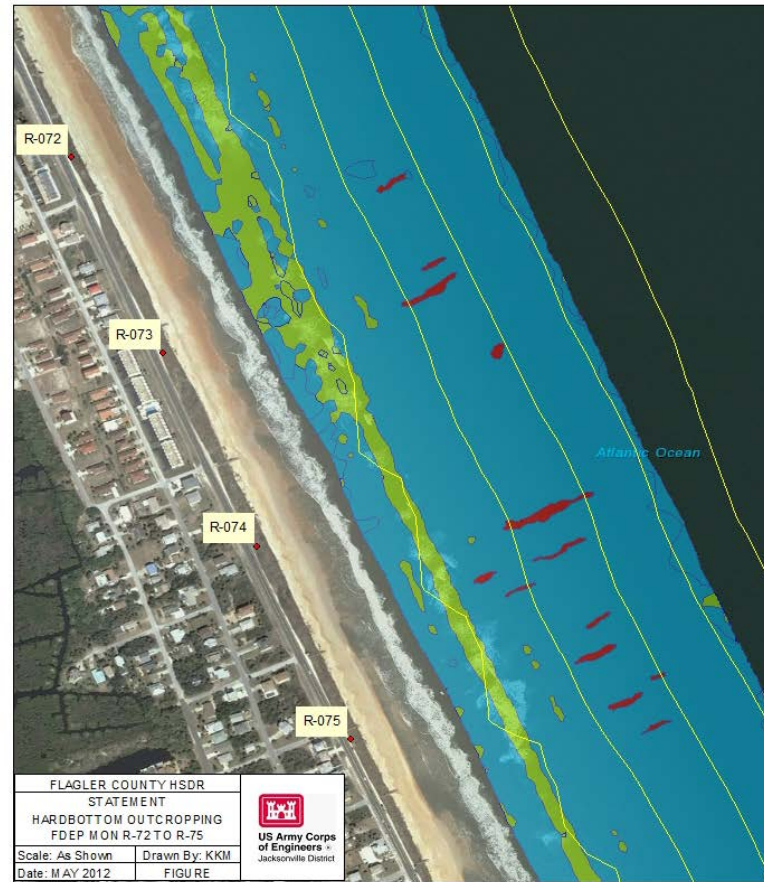
Source: Dial Cordy and Associates, Inc Hardbottom Survey, 2011

Figure 2-22: Presumed Hardbottom in Nearshore from FDEP monument R-50 to R-59



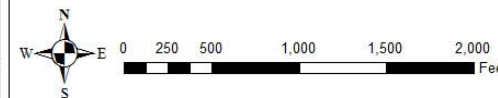
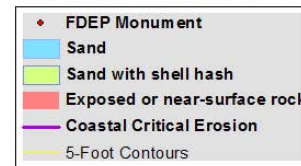
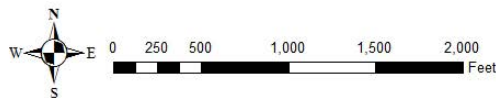
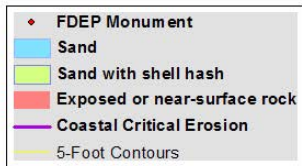
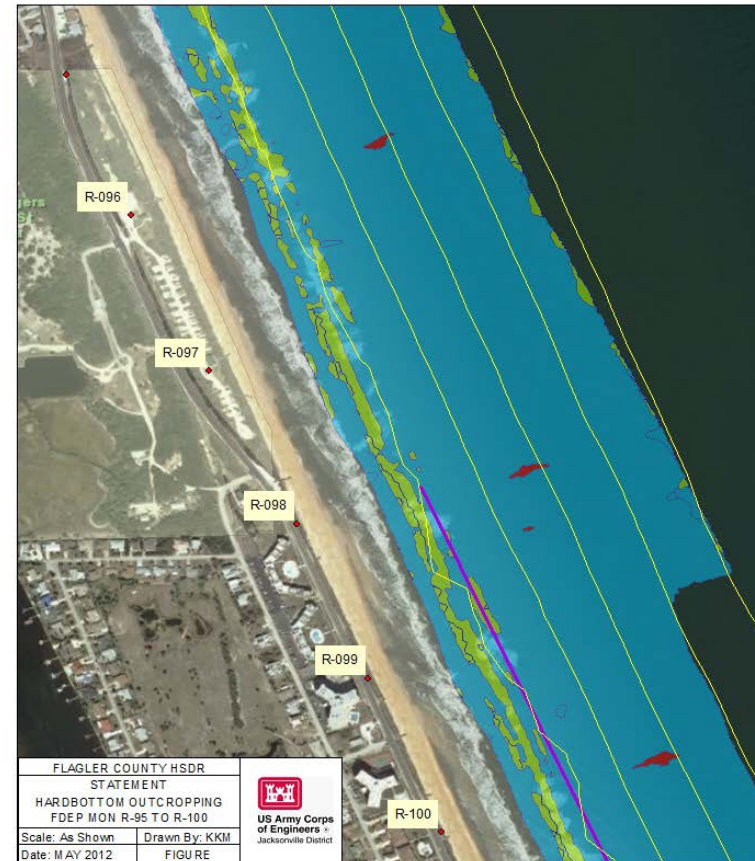
Source: Dial Cordy and Associates, Inc Hardbottom Survey, 2011

**Figure 2-23: Presumed Hardbottom in Nearshore from FDEP monument R-59 to R-69**



Source: Dial Cordy and Associates, Inc Hardbottom Survey, 2011

**Figure 2-24: Presumed Hardbottom in Nearshore from FDEP monument R-72 to R-81**



Source: Dial Cordy and Associates, Inc Hardbottom Survey, 2011

**Figure 2-25: Presumed Hardbottom in Nearshore from FDEP monument R-83 to R-100**

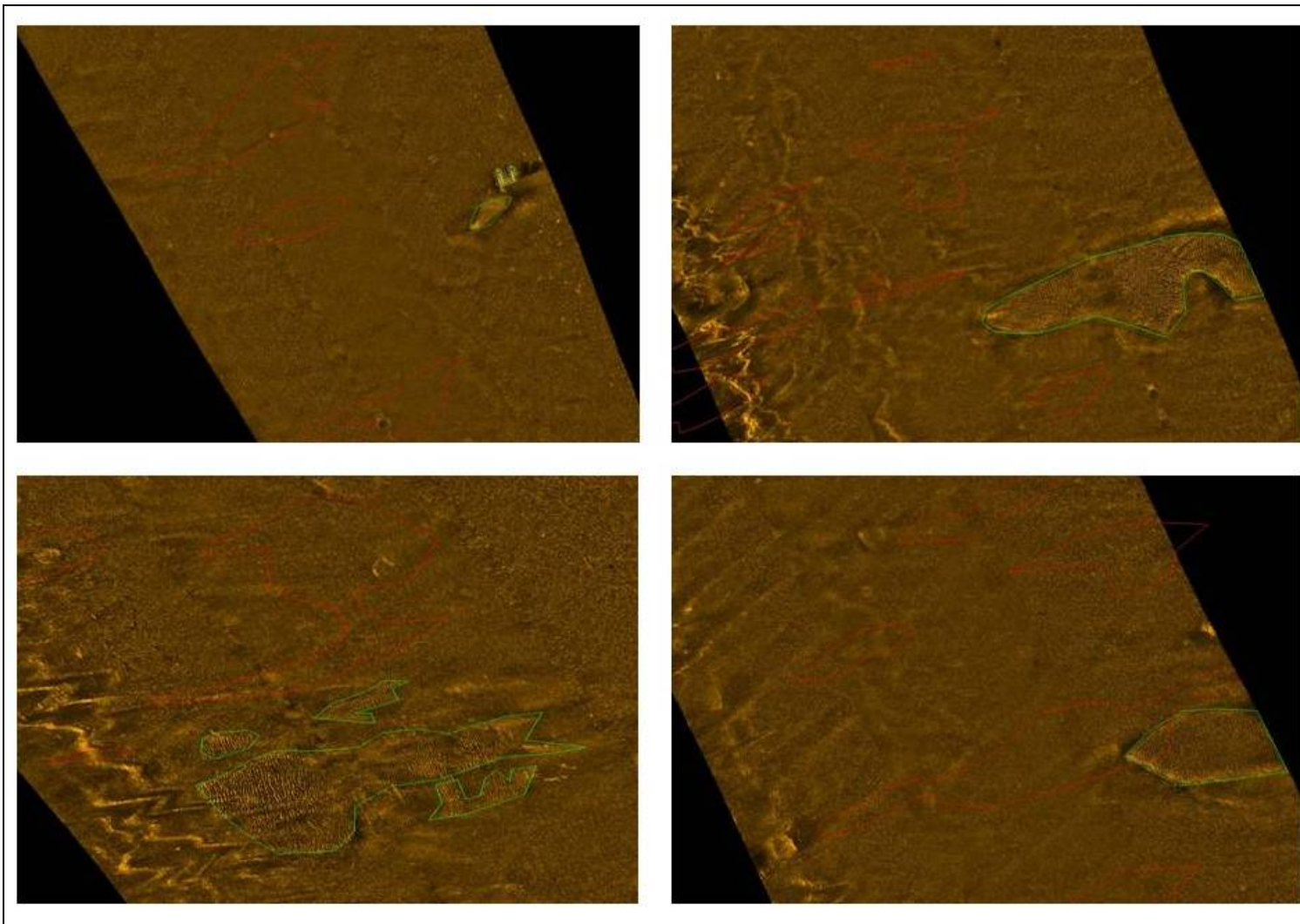
Additional survey of the same area was conducted by the USACE Jacksonville District Hydrographics Survey Section, Operations Division during the summer of 2012 in order to characterize the presumed hardbottom features in the nearshore environment. In addition to sidescan sonar, a multi-beam refractor and towed video were proposed to acquire further detail of the hardbottom such as relief off of the substrate and the presence of macro-algae growing on its surface. However, due to weather conditions at the time of survey, towed video data was unable to be collected. No manned scuba diving was conducted during this specialized survey. The geo-rectified areas indentified from the DCA survey were revisited in August, 2012 and sidescan sonar data was collected again to verify the original findings. No hardbottom features were found during this survey event. The USACE 2012 survey data collection method included use of EdgeTech 4125 Side-scan sonar operating at 400 and 900 kHz. Comparatively, the Dial Cordy and Associates 2011 data was operated at 600 kHz.

**Figure 2-27** show the two sets of survey data overlaying the sidescan sonar mosaic representation of the substrate. The debris shown in **Figure 2-26** was found in both surveys and was used to geo-rectify the locations of the polygons, as shown with the red line (DCA data) overlain by the green line (USACE data). The red polygons are the DCA 2011 survey data of supposed locations of hardbottom features. However, no hardbottom features are present at these sites; the substrate in and adjacent to the features consists of a mostly homogeneous, unconsolidated sand substrate. The USACE 2012 survey data (green polygons) depict the compressed sand ripples adjacent to some of the DCA polygons as well as debris.

One could speculate that the hardbottom features thought to be present at the time of the DCA 2011 survey could have become covered by sand. However, this is an unlikely scenario since some of those features should still be exposed due to differing elevations. It is the Technical Surveyor's opinion (USACE Hydro-survey Division), based on the available survey data, that there is no hardbottom reef in the surveyed area. The current survey data shows no elevated outcroppings or scoured hardbottom areas associated with hardbottom reef. The areas of supposed hardbottom reef were not found in the current survey data as compared to the previous data set. The areas of interest found in the current survey data appear to be compacted sand waves due to their shape, texture, and intensity of signal return. Similar compacted sand waves appear in the previous survey data, but are in different locations and with far less frequency and coverage. Please see the **Environmental Appendix F** for details of these surveys, including the survey methodologies and findings.



**Figure 2-26: Hardbottom data from USACE survey geo-rectified with Dial Cordy Associates (DCA) data (August 2011). DCA data (red-lined polygons) are overlain by USACE Hydro-graphic Division data (green-lined polygons) on USACE collected sidescan data mosaic (August 2012). Note the absence of hardbottom features and presence of compressed sand and ripples.**



**Figure 2-27: Comparison of the DCA 2011 and USACE 2012 substrate surveys. Green polygons (USACE) depict sand ripples whereas red polygons (DCA) delineate supposed hardbottom features. Polygons are overlain on USACE sidescan data.**

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## 2.4.5 Fish and Wildlife Resources

Biological communities found in the study area are well adapted to the particular physiochemical and hydrodynamic conditions associated with the supralittoral beach and the intertidal swash zone (Day 2008). The supralittoral beach, or splash zone, is the fringe that is regularly splashed but not submerged by ocean water (Day 2008). The intertidal (littoral) zone, or swash zone, is the part of the shore that is intermittently covered or exposed by rising and falling tides (Day 2008). Two major physical factors – exposure to both the air and wave action — shape the lives of inhabitants (Day, 2008). The biological communities in the highly dynamic intertidal swash zone must cope with being aerially exposed during normal tidal cycles as well as being subjected to high energy of ocean waves.

Wildlife species generally utilize the supralittoral zone as well as exposed beach and dune within the study area (Day 2008). These consist of small mammals, reptiles, raptors, wading birds, and shorebirds. Forage and game fish, invertebrates and other infauna are found below MLLW in the sublittoral and nearshore of the study area. The presence of fish and infauna attract wildlife to this area. Specifically, these inhabitants may include various terns (*Sterna* spp), gulls (*Laris* spp), and shorebirds like the ruddy turnstone (*Arenaria interpres*), along with medium sized mammals such as raccoon (*Procyon lotor*). Shorebird nesting habitat occurs along the ecotone between the dune and unvegetated beach, although this habitat is marginal in several of the study reaches. Finally, larger pelagic fish and marine mammals, such as tarpon (*Megalops atlanticus*) and bottlenose dolphins (*Tursiops truncates*) are prevalent in the coastal and offshore waters of the study area.

### Infauna

The intertidal zone is shaped constantly as animals and plants are swept away or holdfast species are disrupted, creating opportunities for colonizers to invade any newly opened spaces (Day, 2008). Receding waves tend to wash amphipods (shrimp-like crustaceans) and isopods (small crustaceans such as woodlice) out of their burrows and suspend these organisms in the water column where they serve as an important food source for a variety of nearshore forage and game fish. Following storms, some organisms are found at greater depths in the water column than before the storms occurred, whereas others may be found in concentration along the benthic surface (Dobbs, 1983). A variety of polychaete worms that are also adapted to this highly dynamic and stressful environment can be found within the intertidal zone of the Flagler County coast. These benthic organisms provide an important food source for foraging wading and shore birds. For example, Atlantic coquina (*Donax variabilis*) clams are important in both marine and terrestrial food chains, and are used as indicator species to monitor the ecological health of beaches following shoreline protection projects (Donoghue, 1999). Highly visible decapod crustaceans of the Flagler County upper intertidal zone include the ghost crab (*Ocypode quadrata*), mole crab (*Emerita talpoida*), and Atlantic fiddler crab (*Uca pugilator*). These organisms are highly mobile and burrow



into the moist sand for refuge to retard water evaporation from their bodies during aerial exposure (Barnes 1974).

### Marine Mammals

The Flagler County coast, including the project area, is within the range of the Florida sub-species of the West Indian manatee (*Trichechus manatus latirostris*) and up to 28 cetacean species, with bottlenose dolphin (*Tursiops truncatus*) being most common.

The West Indian manatee has been listed as a protected mammal in Florida since 1893 and is also federally protected under the Marine Mammal Protection Act of 1972 (MMPA) as a depleted species. The manatee was listed as an endangered species throughout its range in 1967 (32 FR 4061) and received Federal protection with the passage of the ESA in 1973. Although critical habitat was designated in 1976 for the Florida subspecies (50 CFR 19.95(a)), there is no federally designated critical habitat in the project's impact area. Florida provided further protection in 1978 by passing the Florida Marine Sanctuary Act designating the state as a manatee sanctuary and providing signage and speed zones in Florida's waterways. It is unlikely that manatees would utilize habitat along the study area as no inlets or access to freshwater exists in the beach coastal area.

Bottlenose dolphins have robust bodies that typically reach 6 to 12 feet as adults. They feed on fish such as mullet and sheepshead, along with marine invertebrates. They live up to 50 or more years, and have weights between 140 kilograms and 650 kilograms. Bottlenose dolphins frequent both inshore and offshore marine waters along temperate and tropical coasts. Inshore dolphins live in small social groups, or pods, of up to 10 individuals, and are frequently sighted along the Flagler County coast. They are highly intelligent and have complex socialization and communication skills. Dolphins along the coast of Florida are protected by Federal law against harassment under the Marine Mammal Protection Act (MMPA) of 1972. (FWC, NMFS, website factsheets).

#### 2.4.6 Essential Fish Habitat

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act of 1996, waters and substrate within the project area have been identified as Essential Fish Habitat (EFH) by the South Atlantic Fishery Management Council (1998). EFH is defined as "those waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity." Important habitats of the South Atlantic region are broadly divided into estuarine/inshore and marine/offshore with many subcategories under each heading. Marine/offshore habitats include coastal, open shelf, live/hardbottom, shelf edge, and lower shelf (SAFMC, 1998). Each of these habitats harbors a distinct assemblage of demersal (close to the ocean floor) fishes and invertebrates. The Flagler County HSDR study area encompasses only marine/offshore habitats and, of these, the reaches of the study area include other major habitats of nearshore hardbottom, soft bottom (open shelf), and the water column with an unconsolidated substrate and high salinity ocean surf zones. Hardbottom discussion is included in **Section 2.4.4**.

### Fishes and Essential Fish Habitat

The fish community of eastern Florida is one of the most diverse in the western Atlantic region. This high diversity is the consequence of biogeographical (geographical distribution of organisms) and environmental factors operating on various spatial and temporal scales (Gilmore, 2001). Overlap of tropical, subtropical, and warm-temperature faunas underlies the transitional nature of the region's biogeography (Gilmore, 2001). Consequently, the resulting composition of species with differing ecological and evolutionary histories can be subdivided into several assemblages and habitats. The primary environmental factor influencing fish distribution in the region is water temperature. Seasonal drops in temperature affect inshore and coastal waters and limit the distribution of subtropical species in inshore waters along the central coastal region including Flagler County. The average water temperature during winter ranges from 15° to 18° C (59° to 64° F) in the study area. Although Flagler County is north of the tropical zone, many fish species still occur in the study area on a seasonal basis. The Gulf Stream brings warm water to the outer shelf of the region, but water temperatures on the outer shelf can decline rapidly as a result of periodic upwelling that originate along the shelf break (Smith, 1983). These features can influence nearshore waters if prevailing conditions promote inshore movement of water masses. In addition to water temperature, other environmental factors important to the distribution and abundance of fish include salinity, dissolved oxygen, turbidity, and hydrodynamics. Three habitats describe fish assemblages occurring in waters of the Flagler County coastal region: demersal soft bottom, coastal pelagic, and demersal hardbottom.

#### Demersal Soft Bottom

The demersal soft bottom fish assemblage that inhabits the open shelf off eastern Florida consists of 213 species in 53 families (Gilmore et al, 1981; Gilmore 2001). Only those species that are managed by the South Atlantic Fishery Management Council (SAFMC) are included in this discussion. These include skates (*Rajidae*), stingrays (*Dasyatidae*), torpedo rays (*Torpedinidae*), cusk-eels (*Ophidiidae*), searobins (*Triiglidae*), flounders (*Bothidae*), sand flounders (*Paealichthyidae*), and soles (*Soleidae*) (SAFMC, 1998). The coastal or nearshore segment of the open shelf (or surf zone), represents the landward extent of this assemblage. Although movements of demersal soft bottom species are not well known, some species, such as flounders, may move along the coast or across the shelf in response to changes in temperature, salinity, dissolved oxygen, or high wave energy, and may occur during a variety of temporal scales ranging from daily to annual (Ross, 1983). Some species may use the surf zone only as juvenile habitat, while others spend most of their life cycle there (Peters and Nelson, 1987). Most demersal soft bottom species feed on infaunal or epifaunal invertebrates, while others like flounder feed in the water column on fishes and decapods (Modde and Ross, 1983).

Penaeid shrimp managed by the SAFMC and potentially occurring in the study area include brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), and white shrimp (*Litopenaeus setiferus*) (SAFMC Website, 2012). For penaeid shrimp, EFH encompasses a series of habitats used throughout their life history with two basic

phases: adult and juvenile benthic phase, and planktonic larval and post-larval phase (SAFMC, 1998). Benthic adults aggregate to spawn in shelf waters over coarse calcareous sediments and feed on zooplankton in the water column as they make their way into inshore waters.

### Coastal Pelagic

The major coastal pelagic families occurring in nearshore waters of eastern Florida are requiem sharks (*Carcharhinidae*), eagle and cownose rays (*Myliobatidae*), ladyfish (*Elopodae*), tarpon (*Magelapodae*), anchovies (*Engraulidae*), herrings (*Clupeidae*), mackerels (*Scombridae*), jacks and pompanos (*Carangidae*), mullets (*Mugilidae*), bluefish (*Pomatomidae*), and cobia (*Rachycentridae*) (SAFMC, 1998). Gilmore et al (1981) reported 91 species from the surf zone habitat of the South Atlantic region; 62 of these species were coastal pelagic. Species associated with the coastal pelagic environment migrate over shelf waters of the nearshore and surf zone throughout the year, although fall and winter are generally the times of peak activity. Some species form large schools, such as cownose rays, anchovies, herrings, and mullets. Other species travel singularly or in small groups, like tarpon, and cobia (SAFMC, 1998). Larger predatory species particularly sharks, tarpon, bluefish, and jack crevalle may be attracted to aggregations of anchovies, herrings, and mullets that typically occur in nearshore areas in late summer or fall. The local distribution of most species depends on water temperature and quality, especially turbidity that fluctuates seasonally (Gilmore, 2001). Rapid drops in air temperature and atmospheric pressure associated with passing cold fronts often initiate southerly migrations of coastal pelagic species including Spanish mackerel and bluefish along the Florida coast.

Coastal sharks commonly occur in inshore or nearshore waters. Several SAFMC managed species that may occur in the study area include blacknose (*Carcharhinus acronotus*), spinner (*C. brevipinna*), bull (*C. leucas*), dusky (*C. obscurus*), sandbar (*C. plumbeus*), tiger (*Gaelocerdo cuvier*), sand tiger (*Carcharias Taurus*), bonnethead (*Spyrna tiburo*), and lemon (*Negaprion brevirostris*). Sharks and rays reproduce through internal fertilization and bear live young or eggs in shelf or inshore waters, species dependent. Females often seek shallow water before releasing live pups or depositing eggs (NMFS, 1999). Sharks are opportunistic scavengers for much of their lives, feeding in both the water column and on the bottom. Ideal EFH identified by NMFS (1999) for shark species include coastal waters within the study area of less than 82-foot (25 meter) depths (SAFMC, 1998).

Coastal pelagic fishes, excluding rays and sharks typically spawn in open shelf waters that result in planktonic eggs and larvae. As larvae transform into juveniles, some may enter inshore estuarine habitats while others, like the Florida pompano, migrate into shallow nearshore where they will remain until obtaining a certain size or age (SAFMC, 1998). Most coastal pelagic fishes feed in the water column on nekton (drifting organisms) or plankton. Diets of individual species diversify with size and age based

upon the corresponding forage morphology of body shape and jaw mechanism. For example, mackerels and jacks change from an early diet of zooplankton-feeding larvae to an opportunistic adult diet consisting of pelagic and benthic organisms. Some species like juvenile and adult pompano, feed mostly on benthic organisms including clams, mole crabs, and other crustaceans. Coastal pelagic species managed by SAFMC include the cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*S. maculatus*), and little tunny (*Euthynnus alletteratus*) (SAFMC, 1998). For the coastal pelagic species, EFH includes sandy shoals of capes and offshore bars, high profile rocky bottom, and barrier island ocean-side waters from the surf zone to the shelf break zone, as well as all coastal inlets and state designated nursery habitats of particular importance to coastal migratory pelagic (SAFMC, 1998).

### Demersal Hardbottom

Hardbottom habitats support the most diverse assemblages of fishes off eastern Florida. Gilmore et al (1981) reported 255 species for offshore reefs and 109 species associated with nearshore hardbottom habitat. Groupers, (*Serranidae*), snappers (*Lutjanidae*), grunts (*Haemulidae*), porgies (*Sparidae*), spadefishes (*Ephippidae*), damselfishes (*Pomacentridae*), and wrasses (*Labridae*) are the most common fish families occupying hardbottom. These groups are tropical and subtropical in origin. The most abundant species reported by Gilmore et al (1981) for the southeastern U.S. coastal region include black margate (*Anisotremus suninamensis*), porkfish (*Anisotremus virginicus*), spottail pinfish (*Diplodus holbrooki*), and hairy blenny (*Labrisomus nuchinipinnis*).

Many reef fishes experience developmental migrations by using a continuum of cross-shelf habitats that are an integral part of their life cycle. Often, species migrate across the shelf from shallow nursery areas before returning to offshore spawning grounds (SAFMC, 1998). Hardbottom, including nearshore hardbottom, provides the connection for young stages of species making developmental migrations from inshore areas to offshore spawning grounds (Lindeman et al, 2000).

Generally, reef fish spawn off shore by releasing eggs and larvae into the water column. Some species of snapper have larvae that are transported into the inshore areas where they settle on the bottom, occupying seagrass meadows. As they mature, the juveniles will move to more structured artificial and natural nearshore hardbottom. Other species of reef fish have similar life cycles as their early stages may inhabit nearshore hardbottom (Lindeman and Snyder, 1999). Nearshore hardbottom provides an important connection among habitats for the cross-shelf developmental pathways undertaken by many reef species (Lindeman et al, 2000). Disruption of habitat connections can alter growth and ultimately reproduction of individuals that contribute to local demographic patterns. Other reef fishes such as damselfishes, blennies, and gobies settle onto reefs for the plankton and remain for their entire lives within a very small area of the habitat. Most reef fishes begin life feeding on zooplankton but change diet with size and age. Some species, such as snappers and groupers, are carnivorous from early stages, changing only the size of the food items as they grow, while others

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feed on zooplankton as juveniles and then switch to benthic prey as they mature (Sweetman, 1993). Consequently, some reef fishes depend on the hardbottom for food, whereas many other depend on plankton and nekton across the reef or surrounding soft bottom areas.

The SAFMC reef fish management group (consisting of snapper and grouper) encompasses 73 species from 10 families. The fisheries and adult habitat of most of these species exist well offshore of the study area; however, the young stages of several reef fishes utilize nearshore hardbottom (SAFMC, 1998). Habitats associated with the study area that have been named by SAFMC as EFH for early life stages of reef fishes include macro-algae, soft sediments, artificial reefs, and live hardbottom. No known presence of hardbottom has been found in the nearshore of Flagler County at this time; subsequent hardbottom resources survey (including presence of macroalgae) for the Borrow Area 2 is underway. Reef fish of importance that are not included in the management by SAFMC include tarpon and common snook (*Centropomus undecimalis*), striped croaker (*Bairdiella sanctaeluciae*), Florida pompano, summer flounder (*Paralichthys dentatus*), and southern flounder (*P. lethostigma*). Furthermore, Florida pompano, flounder, and tarpon are considered to be Aquatic Resources of National Importance (ARNI) by the U.S. Environmental Protection Agency (EPA) under jurisdiction of the Clean Water Act Section 404 (q) 1992 Memorandum of Agreement with USACE (EPA ARNI Website Factsheet, 2012). A summary table of fish species that may spend part of their life cycle in the study area is presented in **Table 2-14**.

**Table 2- 14: Fish Species by Family. Data from the Reef Fish Management Unit for Essential Fish Habitat with anticipated occurrence along coastal Flagler County, Florida**

Family	Common Name	Species	Spawning	Eggs	Larvae	Juveniles	Adults
Serranidae—  Sea Basses  Groupers	Red grouper	<i>Epinephelus morio</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; hardbottom; inshore and shelf waters	Demersal; hardbottoms, shelf waters
	Goliath grouper	<i>Epinephelus itajara</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; hardbottom; inshore and shelf waters	Demersal; hardbottoms, shelf waters
	Gag	<i>Mycteroperca microlepis</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; hardbottom; inshore and shelf waters	Demersal; hardbottoms, shelf waters
	Scamp	<i>Mycteroperca phenax</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; hardbottom; shelf waters	Demersal; hardbottoms, shelf waters
	Black sea bass	<i>Centripristis striata</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; hardbottom; inshore and shelf waters	Demersal; hardbottoms, shelf waters
Carangidae--	Blue runner	<i>Caranx crysos</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; inshore waters	Demersal; hardbottom; inshore; shelf waters
Jacks	Creville jack	<i>Caranx hippos</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; inshore waters	Demersal; hardbottom; inshore; shelf waters
Lutjanidae--  Snappers	Gray snapper	<i>Lutjanus griseus</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; inshore waters	Demersal; hardbottom; inshore; shelf waters
	Lane Snapper	<i>Lutjanus synagris</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; hardbottom; shelf waters	Demersal; hardbottom; inshore; shelf waters
	Vermillion snapper	<i>Rhomboplites aurubans</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; shelf waters	Demersal; hardbottom; inshore; shelf

							waters
<i>Haemulidae--</i>	White grunt	<i>Haemulon plumieri</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; inshore waters	Demersal; hardbottom; inshore; shelf waters
<i>Haemulidae--</i>	Porkfish	<i>Anisotermus virginicus</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; inshore waters	Demersal; hardbottom; inshore; shelf waters
Grunts	Black margate	<i>Anisotermus surinamensis</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; inshore waters	Demersal; hardbottom; inshore; shelf waters
	Sailors choice	<i>Haemulon parra</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; inshore waters	Demersal; hardbottom; inshore; shelf waters
<i>Sparidae--</i> Porgies	Sheepshead	<i>Archosargus probatocephalus</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; inshore waters	Demersal; hardbottom; inshore; shelf waters
<i>Ephippidae--</i> Spadefishes	Atlantic spadefish	<i>Craetodipterus faber</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; inshore and shelf waters	Demersal; hardbottom; inshore; shelf waters
<i>Balistidae--</i> triggerfishes	Gray triggerfish	<i>Balistes capriscus</i>	Shelf waters	Pelagic; shelf waters	Pelagic; shelf waters	Demersal; shelf waters	Demersal; hardbottom; inshore; shelf waters

Source: South Atlantic Fishery Management Council, 1998

#### 2.4.7 Birds

Birds occurring in the study area include mostly wading bird, shorebird and seabird species that use the outer beach and primary dune habitats for roosting, feeding, and/or nesting activities. Species federally protected under the Migratory Bird Act and known to occur as residents or seasonal visitors within Flagler County are summarized in **Table 2-15**, along with abundance and locations where they have been observed. Data acquired from the Flagler Audubon Society in conjunction with the Cornell Lab of Ornithology from 2004 to 2011 show a trend of heavy usage within three reaches of the Flagler County coastline (eBirds website database, 2012). Areas considered as “hotspots” for bird usage by the Flagler Audubon Society include Marineland and Washington Oaks Garden State Park, south Flagler Beach, and Gamble Rodgers Memorial State Recreation Area. No reaches within the Flagler County study area are identified as Important Bird Areas (IBAs). Bird usage of inland areas and the Atlantic

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Intracoastal Waterway are not included in this discussion. Additionally, incidental sightings of seabirds and shorebirds was conducted by a USACE Biologist in August, 2011. A summary of study-specific observations is presented in **Table 2-16**.

Data from the Flagler Audubon Society and Cornell Ornithology Lab (eBirds database website, 2012) include a few other shelf and pelagic seabird species that may seasonally range into near coastal waters of the study area but are not expected to be affected by proposed project activities. These species are as follows:

- Cory's Shearwater (*Caleonectris dioedea*): occasionally comes close to shore from June to November; sighted off Flagler Beach
- Greater Shearwater (*Puffinus gravis*): occasionally comes close to shore from June to November; rare sighting on coastal Flagler County
- Audubon's Shearwater (*Puffinus iherminieri*): rarely comes close to shore in summer
- Northern Gannet (*Morus bassanus*): commonly sighted in winter along the shoreline at Washington Oaks Garden State Park and Gamble Rodgers Memorial State Recreation Area
- Great Scaup (*Aythya marila*): occasional sightings off of Washington Oaks Garden State Park and Flagler Beach; November



**Table 2-15: Shorebirds and near coastal seabirds in Flagler County, Florida**

Common Name	Genus/Species	Sighting Abundance	Location within Flagler County
<b>SHOREBIRDS</b>			
Black-bellied Plover	<i>Pluvalis squatarola</i>	Common	Flagler Beach <sup>1</sup>
Semipalmated Plover	<i>Charadrius semipalmatus</i>	Occasional	Gamble Rodgers Memorial SRA
Wilson's Plover	<i>Charadrius wilsonia</i>	Rare	Gamble Rodgers Memorial SRA
Killdeer	<i>Charadrius vociferous</i>	Occasional	Flagler Beach
Piping Plover*	<i>Charadrius melodus</i>	Rare	Gamble Rodgers Memorial SRA
American Oystercatcher	<i>Haematopus palliatus</i>	Occasional	Flagler Beach
Black-necked Stilt	<i>Himantopus mexicanus</i>	Occasional	Flagler Beach
American Avocet	<i>Recurvirostra Americana</i>	Occasional	Flagler Beach
Wilson's Snipe	<i>Gallinago gallinago</i>	Uncommon	Gamble Rodgers Memorial SRA
Short-billed Dowitcher	<i>Limnodromus griseus</i>	Rare	South Flagler Beach
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	Rare	South Flagler Beach
Marbled Godwit	<i>Limosa fedoa</i>	Occasional	Washington Oaks, Gamble Rodgers Memorial SRA
Whimbrel	<i>Numenius phaeopus</i>	Accidental	Washington Oaks, Gamble Rodgers Memorial SRA
Greater Yellowlegs	<i>Tringa malenoleuca</i>	Occasional	Washington Oaks, Gamble Rodgers Memorial SRA
Lesser Yellowlegs	<i>Tringa flavipes</i>	Common	Flagler Beach
Willet	<i>Catoptrophorus semipalmatus</i>	Occasional	Flagler Beach
Ruddy Turnstone	<i>Arenaria interpres</i>	Occasional	Flagler Beach Pier
Red Knot	<i>Calidris canutus</i>	Occasional	Flagler Beach
Sanderling	<i>Calidris alba</i>	Common	Flagler Beach
Semipalmated Sandpiper	<i>Calidris pusilla</i>	Occasional	Washington Oaks, Gamble Rodgers Memorial SRA
Western Sandpiper	<i>Calidris mauri</i>	Occasional	South Flagler Beach
Least Sandpiper	<i>Calidris minutilla</i>	Common	Flagler Beach
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	Rare	Flagler Beach
Baird's Sandpiper	<i>Calidris bairdii</i>	Accidental	Flagler Beach
Pectoral Sandpiper	<i>Calidris melanotos</i>	Accidental	Flagler Beach
Dunlin	<i>Calidris alpina</i>	Common	Gamble Rodgers Memorial SRA
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	Accidental	Flagler Beach
Red Phalarope	<i>Phalaropus fulicaria</i>	Rare	Gamble Rodgers Memorial SRA
<b>SEABIRDS</b>			

Brown Pelican	<i>Pelicanus occidentalis</i>	Common	Washington Oaks, Gamble Rodgers Memorial SRA
Double-crested Cormorant	<i>Phalacrocorax auritus</i>	Common	Gamble Rodgers Memorial SRA
Ring-billed Gull	<i>Larus delawarensis</i>	Common	Flagler Beach
Great Black-backed Gull	<i>Larus marinus</i>	Uncommon	Flagler Beach Pier
Herring Gull	<i>Larus argentatus</i>	Occasional	Gamble Rodgers Memorial SRA
Bonaparte's Gull	<i>Larus Philadelphia</i>	Common	Flagler Beach
Laughing Gull	<i>Larus atricilla</i>	Common	Flagler Beach
Gull-bill Tern	<i>Sterna nilotica</i>	Accidental	South Flagler Beach
Caspian Tern	<i>Sterna caspia</i>	Uncommon	Flagler Beach
Sandwich Tern	<i>Sterna sandvicensis</i>	Occasional	Beverly Beach
Royal Tern	<i>Sterna maxima</i>	Common	Flagler Beach
Common Tern	<i>Sterna hirundo</i>	Rare	Gamble Rodgers Memorial SRA
Forster's Tern	<i>Sterna forsteri</i>	Common	Flagler Beach Pier
Sooty Tern	<i>Sterna fuscata</i>	Rare	Washington Oaks SP
Black Tern	<i>Chlidonias niger</i>	Common	Flagler Beach
Black Skimmer	<i>Rhynchops niger</i>	Common	Flagler Beach
<b>WADING BIRDS</b>			
Great Blue Heron	<i>Ardea Herodias</i>	Common	Marineland, Washington Oaks SP
Great Egret	<i>Ardea alba</i>	Common	Gamble Rodgers Memorial SRA
Tricolored Heron	<i>Egretta tricolor</i>	Common	Flagler Beach
Little Blue Heron	<i>Egretta caerulea</i>	Common	Flagler Beach
Snowy Egret	<i>Egretta thula</i>	Common	Flagler Beach
Green Egret	<i>Butorides virescens</i>	Uncommon	Flagler Beach
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	Occasional	Marineland, Washington Oaks SP
Yellow-crowned Night Heron	<i>Nycticorax violacea</i>	Uncommon	Marineland, Washington Oaks SP

Source: Flagler Audubon Society and Cornell Ornithology Lab, 2012

\* = Listed as Endangered under the Endangered Species Act of 1973; see Section 2.3.3.3 for full discussion

C = Common – Present in large numbers and widespread; certain to be seen in the right habitat.

U = Uncommon - Present in lower numbers or local in distribution; should be seen with reasonable effort in the correct habitat.

O = Occasional – Present in small numbers or local in distribution. Not expected to be seen without special effort.

R = Rare – in range but not expected to be seen every year. When present, usually in very low numbers or are secretive or very hard to find.

A = Accidental – Either very rare or out of their normal range.

Flagler Beach<sup>1</sup> = Sightings found throughout all Flagler County beaches; not expected to be restricted to any particular location.

**Table 2-16: Bird Sightings within Flagler County HSDR Study Area by USACE Biologist**

Common Name	Scientific Name	Abundance, Location of Sighting
Dunlin	<i>Calidris alpina</i>	Few, Throughout all beaches
Sanderling	<i>Calidris alba</i>	Many, Throughout all beaches
Willet	<i>Catoptrophorus semipalmatus</i>	Few, South Flagler Beach
Osprey	<i>Pandion haliaetus</i>	Two, Gamble Rodgers Memorial SRA
Herring Gull	<i>Larus argentatus</i>	Many, Throughout all beaches
Ring-billed Gull	<i>Larus delawarensis</i>	Many, South Flagler Beach
Bonaparte's Gull	<i>Larus Philadelphia</i>	Few, South Flagler Beach, Gamble Rodgers Memorial SRA
Laughing Gull	<i>Larus atricilla</i>	Many, South Flagler Beach
Snowy Egret	<i>Egretta thula</i>	Few, South Flagler Beach, Gamble Rodgers Memorial SRA
Piping Plover*	<i>Charadrius melodus</i>	Five, Gamble Rodgers Memorial SRA
Royal Tern	<i>Sterna maxima</i>	Many, South Flagler Beach
Forster's Tern	<i>Sterna forsteri</i>	Few, South Flagler Beach
Ruddy Turnstone	<i>Arenaria interpres</i>	Few, Gamble Rodgers Memorial SRA and Flagler Beach Pier

All observations occurred during one-day event (August 2, 2011) by USACE Biologist

\* = Listed as Endangered under the Endangered Species Act of 1973; see Section 2.3.3.3 for full discussion

#### 2.4.8 Cultural, Historical, and Archaeological Resources

Prior to this study, archival research and cultural resource surveys have been conducted along the Flagler County shoreline. Currently, no previously recorded resources are situated within the borrow areas or proposed beach placement areas. No cultural resource surveys have yet to be conducted within the borrow areas and along the nearshore. However, between the shoreline placement areas and the adjacent highway there are resources that are in peril due to continued shoreline erosion. A comprehensive Cultural Resources report entitled *Phase I Cultural Resource Survey as Part of the Flagler County Shoreline Protection Feasibility Study*, for the entire study area between the highway and shoreline, was conducted by Brockington and Associates, Inc. in December 2010. Each potential reach was examined for the presence of resources located either directly on the beach or east of the highway paralleling the beach or contained within the borrow area. The resulting data has led to the documentation of multiple cultural resources of which only a few are significant or potentially significant. There are three known resources located along the Marineland reach. One is an archaeological site and the other two are historic structures. Marineland is listed on the National Register of Historic Places while the Marineland Midden, a known site of past human activity, is reported to contain human remains. The Painters Hill reach does not contain known resources at this time. This determination is based on not having any previous cultural resource surveys in this area. The Beverly

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Beach reach contains only a single known historic structure. The Flagler Beach reach contains five known resources. All five are historic structures.

Within the three identified potential borrow areas and shown in **Figure 2-14**, there are no yet-identified resources as cultural resource surveys have not been conducted in these areas. A Cultural Resource survey of Borrow Area 2, Sub-areas 2A, 2B, and 2C is currently pending.

Marineland opened in June of 1938 as Marine Studios. The innovative oceanarium created an opportunity for the general public to see marine life close-up. Throughout the years, Marineland has pioneered studies in marine science, animal training, water chemistry and more. Since 1938, Marineland has been the first to successfully breed and train dolphins and it was its early scientists who discovered dolphin echolocation, social behavior and communication. The effects of the salt air and hurricanes led to a decline in the structural integrity of many of the pools and artificial habitats that made up Marineland. The Dolphin Café (8FL270), once a component of the Marineland Historic District, was demolished in 2005 because the building had suffered too many alterations to be considered a contributing element to the district. In 2004, older structures were retired, and in early 2006, the Marineland Dolphin Conservation Center opened. The Marineland facility was purchased in 2010 by the Georgia Aquarium, and still provides research, educational and entertainment opportunity to the general public. The conservation center is a modern 1.3 million gallon facility designed with the behavioral needs of the animal, the viewing capabilities of the scientist, the logistical needs of the trainer, and the educational and entertainment needs of the public in mind.

Other previously recorded historically significant architectural properties within the study area include the High Tides at Snack Jack Restaurant (8FL305), and the Flagler Beach Pier (8FL885). The Pier was originally constructed in 1928, but has been reconstructed or significantly repaired numerous times due to continual storm damage and wave action ( **Figure 2-28**). The original entrance pavilion was replaced in 1964 with the current A-framed design. Additionally, the SR A1A Oceanshore Boulevard (8FL286) is a historic landscape feature that extends along the entire length of the survey corridor and is a designated National Scenic Byway eligible for inclusion in the National Register of Historic Places (NRHP).



Source: Brockington and Associates, Inc

**Figure 2-28:** Flagler Beach Fishing Pier Building, circa 1950's

In addition to identified, previously recorded and newly identified resources is a shipwreck report listed on the National Oceanic and Atmospheric Administration (NOAA) nautical charts for the area. This shipwreck/obstruction is indicated to be offshore of Flagler County but recently during biological hardbottom investigations, a potential wreck was identified in the nearshore area. A USACE survey vessel took a closer look at the reported NOAA shipwreck and confirmed that the map location is in error and the shipwreck is located in the immediate nearshore. The vessel, based on the remains of its shape and construction, may be the “Northwestern”, a steam freighter built in 1881 and sunk in 1920. However, further investigation is needed to confirm this identification.

Because of the rich history of over 500 years of historic use and over thousands of years of prehistoric use, there continues to be high potential for the discovery of significant resources within the coastal environment of Flagler Beach. Prior to potential dredging and project implementation, areas of proposed work will be subjected to additional resource investigations to identify and evaluate resources. A comprehensive Cultural Resources report for the entire study area conducted by Brockington and Associates, Inc. is included in the **Environmental Appendix**.

## 2.4.9 Aesthetics

Consideration of aesthetic resources is required by NEPA, as amended and USACE Engineering Regulation (ER) 1105-2-100. Aesthetic resources are defined as “those natural and cultural features of the environment that elicit a pleasurable response” from the observer, most notably from the predominantly visual sense. The uniquely colored orange sand of Flagler County beaches, as well as the ability to see the beach, dunes, and ocean from SR A1A, is an example of additional aesthetic qualities valued by members of the community as shown in **Figure 2-29**. These values are subjective, and as such, the erosional features of the beach and its adverse impact to the area’s aesthetic quality cannot be effectively quantified.



**Figure 2-29: Aesthetic view shed along Flagler Beach. With its distinct orange color, coquina-derived shell hash composes the upper beach material making Flagler County beaches unique throughout Florida. Low dunes and beaches along SR A1A provide an aesthetically pleasing view shed from this historic roadway.**

### 2.4.10 Recreation

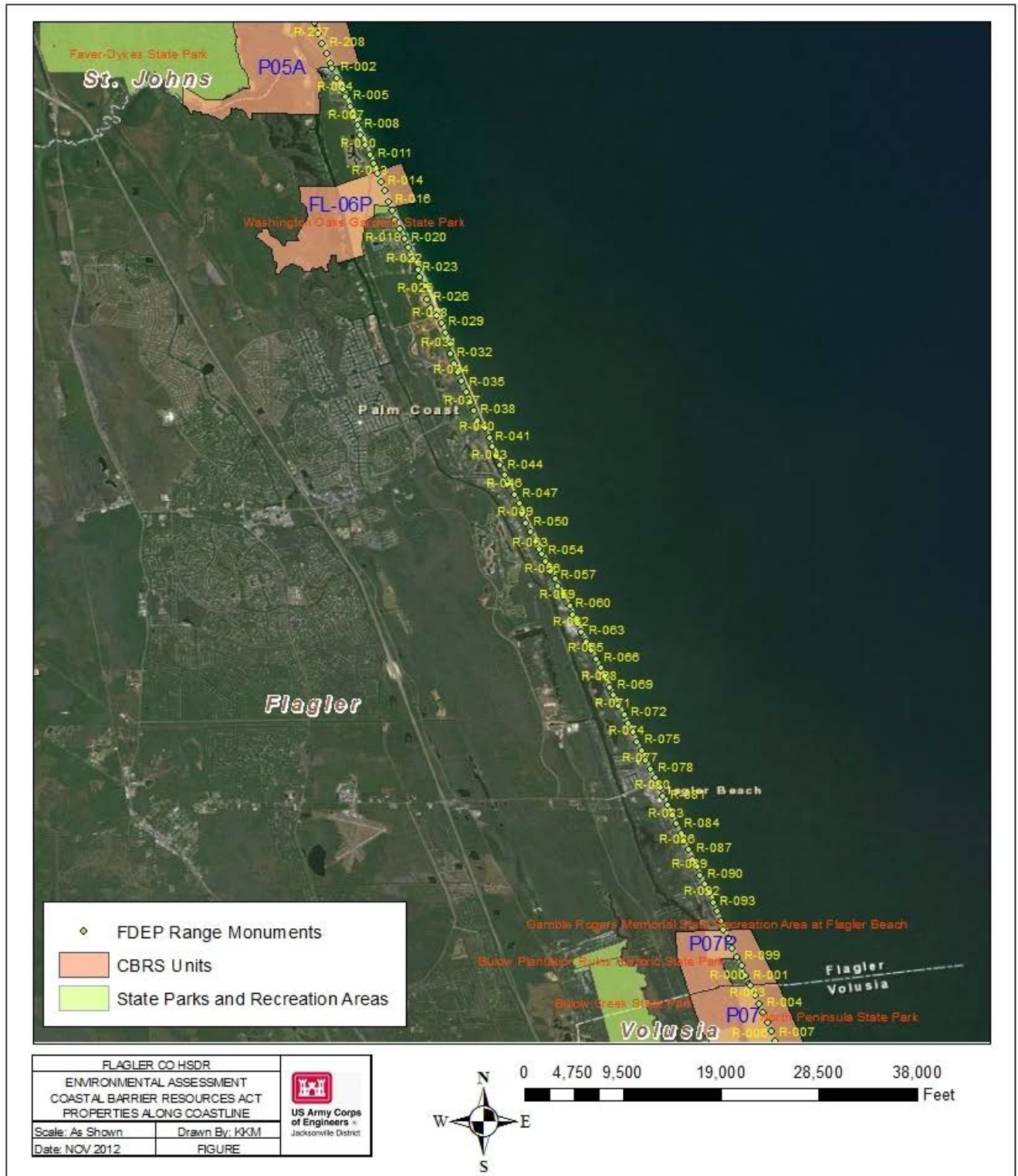
The project area is a favorite for county residents to spend their leisure time sunbathing, swimming, surfing, walking, and fishing, in addition to a variety of other active and passive activities. However, the recreational capacity and potential of the beach within the limits of the project are being threatened with ongoing erosion. The spring, summer, and fall months of the year are the most active times with the summer months comprising the peak use period. During the winter months, the Flagler County beaches are generally used by relatively few people due primarily to low temperatures (40°F to 60°F) and the frequency of northeast winds which produce strong waves and high tides.

In 2010, the total number of beach visits in Flagler County was estimated to be 626,467 (for the entire year). This estimate is based on projections provided by the State of Florida "Trends and Conditions Report - 2008" for northeast Florida, the 2007 Florida Statewide Recreation Plan (SCORP), and county tourism allocation projections developed for the Nassau County Florida General Reevaluation Report (USACE 2008). The number of visits is projected to increase to 791,295 by 2020 and 1,265,250 by 2050.

Incidental recreation benefits will be measured using the Unit Day Value (UDV) method, in accordance with Appendix E of ER 1105-2-100 and USACE Economic Guidance Memo #12-03, *Unit Day Values for Recreation*, FY 2013. More information about the recreation analysis is provided in Section 6 of this report and in **Appendix C**.

### 2.4.11 Coastal Barrier Resources

The Coastal Barrier Resources Act (CBRA) of 1982 (FWS PL 97-348) discourages development on largely undeveloped coastal barriers along the Atlantic, Gulf, and Great Lakes coasts by prohibiting use of Federal expenditures. The purpose of the Act is to remove the Federal incentive to develop these areas by making them ineligible for Federal expenditure and financial assistance. This encourages conservation of hurricane prone, bio-rich coastal barriers by restricting Federal expenditure in the sensitive habitats (<http://www.fws.gov/CBRA/index.html>). CBRA Unit P05A Matanzas River lies immediately north of the Marineland study reach outside of the study area. CBRA Unit P06P, an Otherwise Protected Area (OPA) is located at the Washington Oaks Garden State park from FDEP monument R-12 to R-16 and is within the study area. OPAs are generally comprised of lands that are intended for natural resource conservation or recreational usage. CBRA Unit P07P is another OPA that lies immediately south of the Flagler Beach reach at the Gamble Rodgers Memorial State Recreation Area from R-95 to R-101. It is within the study area, as depicted on **Figure 2-30**.



**Figure 2-30: Coastal Barrier Resources Act (CBRA) units within Study Area. Note no units are located within the proposed Recommended Plan limits from FDEP monument R-65 to R-95.**



## 2.4.12 Water Quality

The waters off coastal Flagler County within the study area are listed as Class III waters under the criterion as “suitable for fish consumption, recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife” (Ch 62-302.400 (1) F.A.C.). Classifications are arranged in order of the degree of protection required, with Class I water having generally the most stringent water quality criteria, and Class V the least. However, Class I, II and III surface waters share water quality criteria established to protect fish consumption, recreation, and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife (Ch. 62-302.400 (4) F.A.C.).

Turbidity is a major limiting factor for coastal water quality in South Florida. Turbidity, expressed in Nephelometric Turbidity Units (NTU), quantitatively measures the light-scattering properties of the water. However, the properties of the material suspended in the water column that create turbid conditions are not reflected in turbidity measurements. The two reported major sources of turbidity in coastal areas are very fine organic particulate matter, and sand-sized sediments that are re-suspended around the seabed by local waves and currents (Dompe and Haynes, 1993). Turbidity values are generally lowest in the summer months and highest in the winter months, corresponding with winter storm events and the rainy season (Dompe and Haynes, 1993). Specific turbidity levels within the reaches of the study area are not currently available.

Threats from water-borne pathogens can cause diseases such as Hepatitis A, viral and bacterial gastroenteritis, typhoid fever, and dysentery. Through the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000, the EPA has authority to keep the coastal recreation areas healthy and safe for public usage by adoption of marine surface water quality standards (EPA BEACH website). This allows the EPA to award eligible states the grants needed to develop and implement standards consistent with the Act requirements. The health and safety of public beaches are determined by water sampling and analysis for contamination from fecal matter (L. Leiendecker, 2007). In Florida, the Act is administered by the Department of Health (DOH) through the Florida Healthy Beaches Program (DOH website, 2004). In 1986, the EPA established the *Ambient Water Quality Criteria for Bacteria* (EPA 440/5-84-002) as the guidance to meet the requirement standards set forth by the BEACH Act of 2000. The EPA criteria identified *E. coli* and *Enterococci* as two recommended indicators to assess the microbiological safety of water (L. Leiendecker, 2007). Fecal coliform is a general term that encompasses all coliform bacteria, including *E. Coli*, found in human intestines. *Enterococci* are the bacteria that thrive in the intestinal tract of mammals and birds. Common sources for these bacteria are wastewater, failing septic systems, dog feces, and sewer water (EPA website, 2012). These bacterial indicators do not necessarily harm humans, but high levels suggest a high probability of dangerous pathogen contamination from feces (L. Leiendecker, 2007). In addition to adopting fecal coliform as an indicator organism for bacterial contamination, DOH used

the 1986 EPA guidance to implement *Enterococci* monitoring along with fecal coliform to fulfill both state and Federal requirements (DOH website, 2012).

Since the enactment of BEACH Act in 2000, sample analytical data has been submitted to the EPA by the Florida DOH, who is responsible for the reporting. Data collected from Flagler County include the following beaches:

- Gamble Rodgers Memorial State Recreation Area
- North Flagler Pier
- Beverly Beach (including Varn Park)
- South Flagler Pier
- Washington Oaks State Park

The beaches are monitored year round, starting in the year 2000, and continue through the present (June, 2012). The standards set forth by the EPA are as follows:

- Good: 0 to 35 *Enterococcus* per 100 ml of marine water, or the Geometric standard of 0 to 35 Colony Forming Units (CFU) per 100 ml of marine water; 0 to 199 fecal coliform organisms per 100 ml of marine water
- Advisory : >36 *Enterococcus* per 100 ml of marine water, or the Geometric standard of >36 CFU/100 ml of marine water; >200 fecal coliform organisms per 100 ml of marine water
- Warning: Geometric standard of >400 CFU/100 ml of marine water

BEACH Act data collected from Flagler County beaches listed above from January 2004 to June 2012 determined that of all samples collected, none were found to exceed the state or Federal standards. Furthermore, there have been no advisories issued, nor have any beaches been forced to close due to threat of unsafe conditions for public recreational usage (DOH website, 2012).

Beaches not included in the monitoring include Hammock Beach, Marineland, and South Flagler Beach.

#### 2.4.13 Hazardous, Toxic, and Radioactive Waste

There are currently no identified hazardous, toxic, and radioactive waste producers within or adjacent to the study area that could discharge effluent near the Flagler County shoreline.

#### 2.4.14 Air Quality

The urbanization of the beaches within Flagler County, along with their popularity, contributes to a large number of motorized vehicles in the vicinity of the study area at

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any given time. However, because of the sea breezes that are usually present along the shore, air quality is generally regarded as good as airborne pollutants are readily dispersed by the ocean generated winds. "Florida is one of only three states east of the Mississippi River to meet all national ambient air quality standards established by the EPA to protect public health, including air quality standards for ground-level ozone."

([www.dep.state.fl.us/secretary/](http://www.dep.state.fl.us/secretary/))

#### 2.4.15 Noise

Ambient noise levels in Flagler County are low to moderate and are typical of recreational environments. The major noise producers include the breaking surf, adjacent commercial and residential areas, and traffic (boat, vehicular, and airplane).

#### 2.4.16 Native Americans

Numerous antiquities and cultural resources are recorded within the proposed project area. Amongst the previous recorded sites are resources that can be identified with Native American use. The Marineland Midden, a mound reported to contain human remains, is within the Marineland reach. The National Register of Historic Places eligibility has yet to be determined for this midden. No portion of this project will affect tribal lands located in the State of Florida.

## 2.5 Economic Conditions

Information on the existing economic conditions along the Flagler County coastline was collected for economic modeling purposes using Beach-*fx*. Beach-*fx* is a USACE Monte Carlo life-cycle simulation model for estimating shore protection project evolution and cost benefit analyses. The information on the coastal assets detailed in this section was collected from Flagler County mapping resources, site visits, and contractors. Each parcel along the beach was identified as developed or undeveloped, with streets and parks noted. USACE real estate specialists provided depreciated replacement value of existing structures within the study area. Coastal armor was inventoried, categorized, and valued based on its composition and level of protection afforded.

The Flagler County study area was disaggregated into 4 study reaches, consisting of 13 profiles, 50 model reaches, 1,372 lots, and 1,476 damage elements for economic modeling and reporting purposes. This hierarchical structure is depicted as follows:

- Study Reaches: Consists of the political/administrative boundaries of the following cities, townships, municipalities: Marineland, Painters Hill, Beverly Beach, and Flagler Beach.
  - Profiles: Coastal surveys of the shoreline modified by USACE Jacksonville District (SAJ) coastal engineering personnel to apply coastal morphology changes to the model reach level. Profiles are strictly used for modeling purposes, and only referred to in this section for informational purposes.
    - Beach-Fx Model Reaches: Quadrilaterals parallel with the shoreline used to incorporate coastal morphology changes for transfer to the lot level. Model reaches are also useful for dividing study reaches into more manageable segments for analysis.
      - Lots: Quadrilaterals encapsulated within model reaches used to transfer coastal morphology changes to the damage element. Lots are also repositories for coastal armor costs, specifications, and failure threshold information; referred to in this section for information purposes only.
        - Damage Elements: Represents a unit of the existing condition coastal inventory and a store of economic value subject to losses from wave attack, inundation, and erosion damages. Damage elements are a primary model input and the topic of focus in this discussion. The 24 damage element types have been grouped into 5 categories for reporting purposes. Examples of damage elements are residential structures, patios, dune walkovers, and paved roads.

The distribution of study reaches, profiles, model reaches, lots, and damage elements for Flagler County are depicted further in **Table 2-17**.

**Table 2-17: Flagler County Study Area**

Flagler County Study Area Composition					Total #
<b>Study Reaches:</b>	Marineland	Painters Hill	Beverly Beach	Flagler Beach	
<b>Profiles:</b>	\$ 2	\$ 2	\$ 1	\$ 2	6
<b>Model Reaches:</b>	\$ 4	\$ 10	\$ 5	\$ 31	50
<b>Lots:</b>	\$ 5	\$ 106	\$ 36	\$ 168	315
<b>Damage Elements:</b>	\$ 25	\$ 368	\$ 154	\$ 1,027	1574
Note: One Profile extends through both Painter's Hill and Beverly Beach. This is why there are only six total profiles even though the sum of columns equals seven.					

### 2.5.1 Data Collection

Economists have collected and compiled detailed information for 9.6 miles of Flagler County's 18 mile coastline, from the Mean High Water (MHW) line to 400 feet inland. This area includes: over 600 single family homes; 102 different multi-family structures; 124 commercial buildings; 9.6 miles of road; and over 477 other structures that are vulnerable to future hurricane and storm damages. In addition, data was collected on coastal armor within Flagler County. In total, over 1,500 damageable structures were collected for economic modeling using Beach-fx.

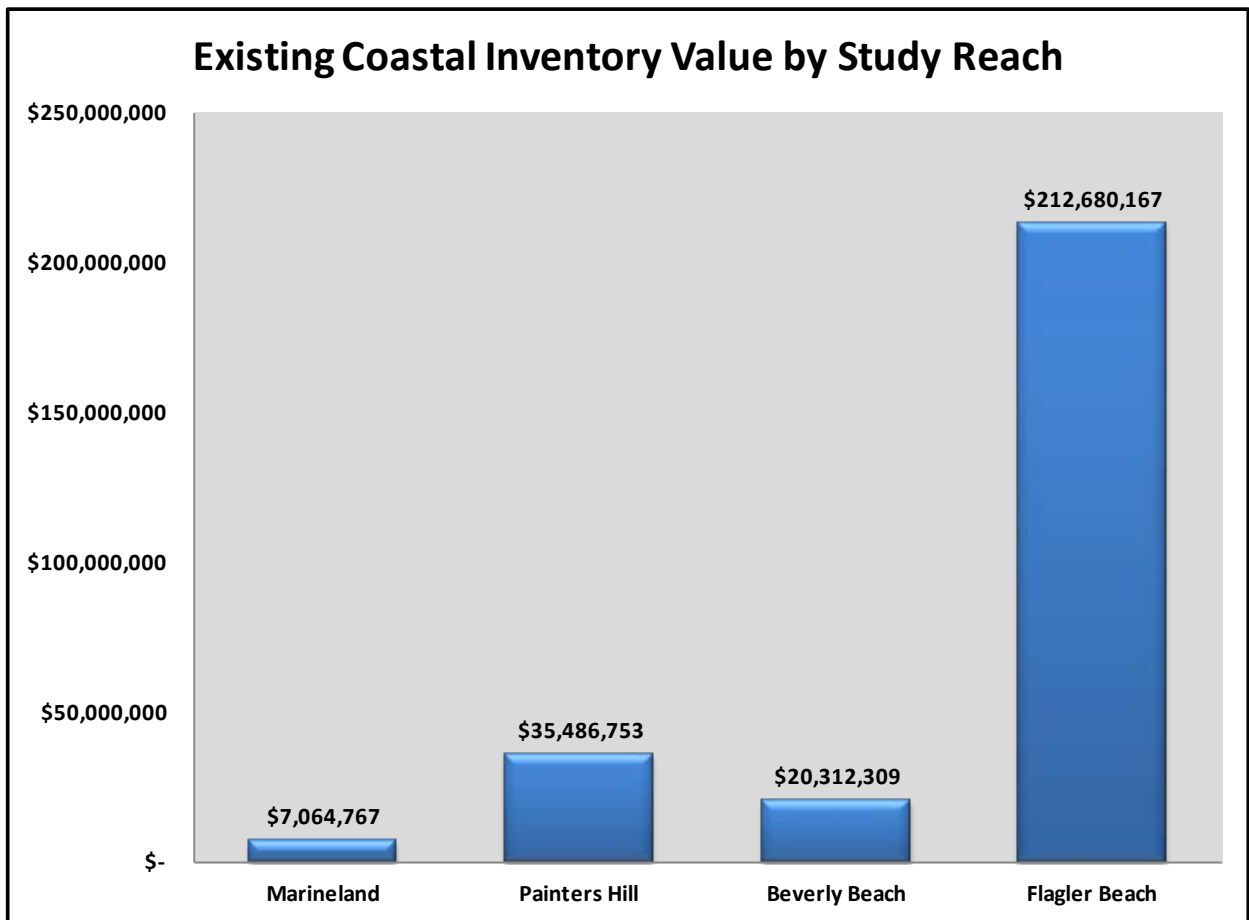
Real Estate professionals from the USACE SAJ district using geospatial parcel data from Flagler County provided detailed data on each structure including: geographic location, structure type, foundation type, construction type, width, length, number of floors, depreciated replacement value, and year built. Elevation data for enclosed structures was collected by a survey contractor and FEMA elevation certificates were provided by Flagler County. The elevations of paved surfaces such as roads and parking lots were acquired from USACE SAJ LIDAR data.

Data on all coastal armor was collected from a variety of sources including Florida Department of Transportation (FDOT) contractors, site visits, aerial orthophotography, and USACE SAJ Coastal Engineering personnel. Coastal armor value was determined by USACE SAJ Cost Engineering personnel.

### 2.5.2 Value of Existing Inventory

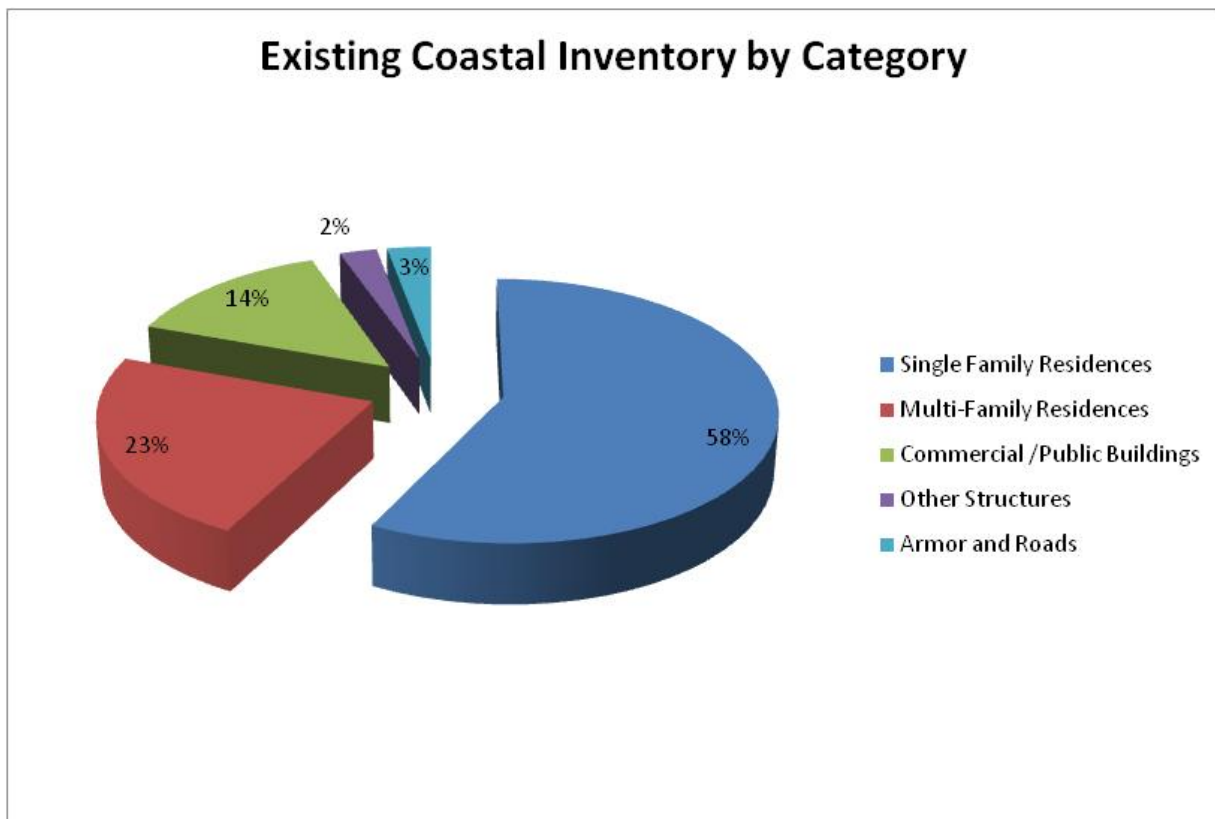
The economic value of the existing Flagler County structure inventory represents the depreciated replacement costs of damageable structures and their associated contents along the coastline. Real Estate professionals from the USACE SAJ district worked together with economists and planners to provide economic valuations for all of the damageable structures.

**Figure 2-31** shows the existing inventory value by reach. The Flagler Beach reach has the majority of inventory value.



**Figure 2-31: Existing coastal infrastructure value by study reach.**

A graphical representation of inventory value by category is provided in **Figure 2-32**.



**Figure 2-32: Proportional Existing Coastal Inventory Value by Category**

A content to structure value ratio (CSV) of 50% was used per guidance contained in ER 1105-2-100. Total structure and content valuations equal \$190 M and \$85.4 M respectively. **Table 2- 18** provides detail on the existing coastal inventory by category and type.

**Table 2- 18: Existing Coastal Inventory by Damage Element Category & Type**

Flagler County Study Area Inventory				
Structure Category and Type	Structure #	Structure Value	Contents Value	Total Value
<b>Single Family Residences</b>	<b>607</b>	<b>\$ 90,442,033</b>	<b>\$ 45,221,016</b>	<b>\$ 135,663,049</b>
Single Family Residence 1 Story	263	\$ 19,231,488	\$ 9,615,744	\$ 28,847,233
Single Family Residence 2 Story	118	\$ 42,278,535	\$ 21,139,266	\$ 63,417,801
Single Family Residence 3 Story	198	\$ 28,217,700	\$ 14,108,850	\$ 42,326,550
Manufactured Single Family Residence	28	\$ 714,310	\$ 357,155	\$ 1,071,465
<b>Multi-Family Residences</b>	<b>102</b>	<b>\$ 49,586,300</b>	<b>\$ 24,793,150</b>	<b>\$ 74,379,450</b>
Multi-Family Residences 1 Story	33	\$ 4,478,350	\$ 2,239,175	\$ 6,717,525
Multi-Family Residences 2 Story	60	\$ 25,509,950	\$ 12,754,975	\$ 38,264,925
Multi-Family Residences 3 Story	2	\$ 5,194,000	\$ 2,597,000	\$ 7,791,000
Multi-Family Residences 4 Story	6	\$ 9,504,000	\$ 4,752,000	\$ 14,256,000
Large Multi-Story High Rise	1	\$ 4,900,000	\$ 2,450,000	\$ 7,350,000
<b>Commercial /Public Buildings</b>	<b>124</b>	<b>\$ 32,663,532</b>	<b>\$ 15,114,742</b>	<b>\$ 47,778,273</b>
Commercial Structure 1 Story	70	\$ 12,949,750	\$ 6,614,475	\$ 19,564,224
Commercial Structure 2 Story	42	\$ 10,043,382	\$ 5,021,691	\$ 15,065,073
Commercial Structure 3 Story	4	\$ 5,580,000	\$ 2,790,000	\$ 8,370,000
Public Structure 1	7	\$ 2,375,400	\$ 448,476	\$ 2,823,876
Public Structure 2	1	\$ 1,715,000	\$ 240,100	\$ 1,955,100
<b>Other Structures</b>	<b>453</b>	<b>\$ 9,179,298</b>	<b>\$ 859,560</b>	<b>\$ 10,038,858</b>
Parking Lots	44	\$ 1,471,815	\$ -	\$ 1,471,815
Other paved surfaces (shuffleboard court)	1	\$ 11,280	\$ -	\$ 11,280
Dunewalks	186	\$ 2,322,347	\$ -	\$ 2,322,347
Wood decks	66	\$ 982,936	\$ -	\$ 982,936
Swimming Pools	79	\$ 2,416,200	\$ -	\$ 2,416,200
Storage Buildings	22	\$ 464,220	\$ 232,110	\$ 696,330
Tennis Courts	5	\$ 225,600	\$ -	\$ 225,600
Large tent in Marineland	1	\$ 30,000	\$ -	\$ 30,000
Residential Garages	49	\$ 1,254,900	\$ 627,450	\$ 1,882,350
				\$ -
<b>Subtotal - Structures and Contents</b>	<b>1,286</b>	<b>\$ 181,871,163</b>	<b>\$ 85,988,467</b>	<b>\$ 267,859,630</b>
				\$ -
<b>Armor and Roads</b>		<b>\$ 9,566,716</b>	<b>\$ -</b>	<b>\$ 9,566,716</b>
Armor and Roads	288	\$ 9,566,716		\$ 9,566,716
				\$ -
<b>Grand Total</b>	<b>1,574</b>	<b>191,437,879</b>	<b>85,988,467</b>	<b>\$ 277,426,346</b>



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### Single-Family Residences

Single-family residences comprise 58% of the existing value within the study area (Figure 2-31). Even though single-family residences constitute the greatest overall value within the study area, they are of less value per structure relative to multi-family and commercial structures. The majority of the structure inventory of the Painters Hill and Beverly Beach study reaches consists of single-family residential structures and their associated amenities (decks, pools, dune walks, etc.).

### Multi-Family Residences

Multi-family residences constitute 23% of the existing value. Damage elements within this category tend to be more substantial in terms of construction, and contain the greatest amount of economic value per structure within the study area. This is particularly true of Beverly Beach. Thus, the distribution of value within Beverly Beach is concentrated in its southernmost section.

### Commercial / Public Structures

Commercial and public buildings represent 14% of the overall study area value. Similar to multi-family structures, commercial/public buildings tend to be more robust in terms of construction, and have greater value per structure. Commercial/public structures are more prevalent in Flagler Beach. The Marineland study reach inventory consists primarily of a small number of high value commercial/public facilities.

### Armor and Roads and Critical Infrastructure

The armor and roads category contains 3% of the damageable value. SR A1A is the primary transportation infrastructure of concern within the study area. According to 2008 FDOT figures, average annual daily traffic along the segments of SR A1A within the four study reaches is as follows:

- Marineland: 4,950 vehicles
- Painters Hill: 4,400 vehicles
- Beverly Beach: 4,650 vehicles
- Flagler Beach: 7,040 vehicles

Coastal armor within the study area was categorized into a number of different types based on construction type, material and elevation. The types of coastal armor were granite revetments, precast concrete panel seawalls, steel sheet pile sea walls, and vinyl bulkheads.

Coastal armor in Marineland consists of a 1,550-foot granite revetment and a 1,000-foot steel sheet pile sea wall covered by a dune. This shoreline protection effort was improved and expanded after Hurricane Floyd caused significant damage to the area in 1999.

The only coastal armor found in Painters Hill were two lots with vinyl bulkhead armor units with crest elevations at grade level. In Beverly Beach there is a large 1,560 foot precast concrete panel seawall providing protection for an RV park.

Flagler Beach has the most armor in the study area, much of which is in varying stages of disrepair. There is a 420-foot precast concrete panel seawall starting 285 feet north of the pier. Starting at 7<sup>th</sup> Street South and ending at 23<sup>rd</sup> Street South, there is approximately 9,000 feet of granite revetment maintained by FDOT. This revetment was originally built in the 1960s and 1970s, with additional newer stone placed during maintenance and repairs. Between 2000 and 2007, FDOT maintenance costs for SR A1A in Flagler Beach averaged \$1.25 million per year (FDOT, 2010). FDOT funds repairs from the state budget as available. If damage is caused by a storm event that has been declared an emergency by the Governor of Florida, FDOT seeks reimbursement from the Federal government. Within this revetted area is a 150-foot steel sheet pile sea wall with a concrete cap between 12<sup>th</sup> Street South and 13<sup>th</sup> Street South. This armor unit was constructed in December 2005 by FDOT to protect SR A1A from being undermined by erosion. Approximately 410 feet south of 28<sup>th</sup> Street are small precast concrete panel seawalls protecting several commercial properties toward the southern end of the county.

#### Other Structures

The remaining 2% of Flagler County's structure value consists of relatively lower value damageable elements such as garages, storage buildings, dune walks, decks, swimming pools, wood shelters, and parking lots. However, these structures constitute \$8,200,000 of the study area's existing inventory. Many of these structures serve as amenities for the aforementioned single and multi-family residential structures.

SR A1A is by far the most vulnerable critical infrastructure within the study area. Police, emergency rescue, hospitals, and other critical facilities are not constructed within the study area.

## 2.6 Public Access and Parking

USACE SAJ district personnel have conducted several parking and access windshield surveys since 2008. Information from these surveys shows that approximately 5.98 miles of the 9.62 mile study area are publicly accessible with adequate parking.

The Marineland study reach contains 4 public access points along a public boardwalk to the south of the oceanarium. Approximately 160 parking spaces are available for beach goers within this study reach.

Public access and parking is limited in the Painters Hill and Beverly Beach study reaches. Approximately 50 parking spaces and public access is located about 1,000 feet north of the Painters Hill study reach at Varn Park. At the south end of Beverly

Beach, public access is available from R-64 to R-67 with approximately 30 parking spaces along the shoulder of SR A1A.

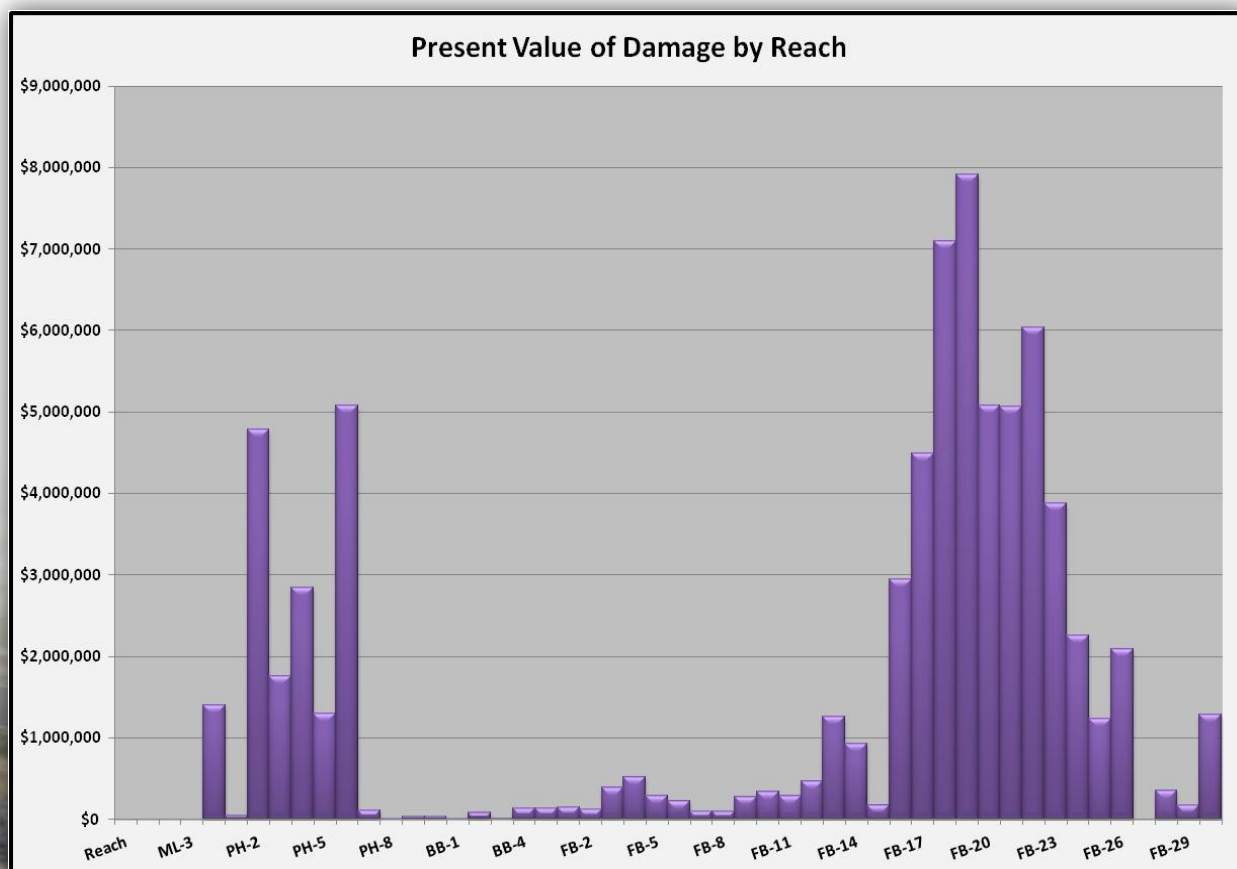
Public access is provided at most street ends in the Flagler Beach study reach with approximately 410 public parking spaces located throughout the study reach.

Federal participation in shore protection projects is limited to shorelines open to public use. Guidance is provided in Engineering Regulation (ER) 1105-2-100 and ER 1165-2-130. Cost sharing for the Recommended Plan is based on shoreline ownership and the availability of public access. Parking and access related to the Recommended Plan is detailed in **Section 5.3.5**.

# CHAPTER 3

## FUTURE WITHOUT PROJECT CONDITIONS

BEACH-FX OUTPUT ILLUSTRATING WITHOUT PROJECT DAMAGES



FLAGLER COUNTY, FLORIDA  
HURRICANE AND STORM DAMAGE REDUCTION PROJECT  
FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

**CHAPTER 3**  
**FUTURE WITHOUT PROJECT CONDITION**

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### 3 FUTURE WITHOUT-PROJECT CONDITION

#### 3.1 General

The future without-project condition is the most likely condition of the study area, over the next 50 years, without construction of a Federal Hurricane and Storm Damage Reduction (HSDR) project. The period of analysis starts at the base year (when construction would be complete) of 2018 and ends at 2068. Recent climate research by the Intergovernmental Panel on Climate Change (IPCC, 2007) has predicted continued or accelerated global warming for the 21<sup>st</sup> century and possibly beyond. One impact of continued global warming is the rise of global mean sea level (USACE, 2009). Due to the combination of rising sea level and continued storm activity, it is projected that erosion in the study area will continue in the future and infrastructure damage will occur due to storms. It is assumed that any project recommended by this study will not increase development in the project area. Sections 3.2 through 3.4 summarize some of the physical, social, and economic conditions, and related assumptions, which were input into the U.S. Army Corps of Engineers (USACE) Beach-*fx* model in order to develop the most probable future without-project condition for the study area.

#### 3.2 Physical Conditions

Historical rates of shoreline erosion were projected to future years in order to locate the shoreline position 50 years from now. As the beach erodes, less beach will be available to protect against other storm damages such as waves and inundation.

Each of the study reaches, with the exception of Beverly Beach, have relatively consistent average shoreline rates of change, ranging from -0.58 feet/year to -0.67 feet/year (**Table 3-1**). Due primarily to the stabilizing presence of a concrete and steel seawall over a significant portion of the reach, Beverly Beach experiences a lower shoreline rate of change, approximately -0.11 feet/year.

**Table 3-1: Annual Shoreline Rate of Change by Study Reach**

Project Segment	Study Reach	Location (DNR Monument)	MHW Rate of Change (1972 – 2007) (feet/year)
North	Marineland	R-1 to R-4	-0.58
TOTAL (North)		R-1 to R-4	-0.58
South	Painters Hill	R-50 to R-60	-0.64
	Beverly Beach	R-60 to R-67	-0.11
	Flagler Beach	R-67 to R-101	-0.67
TOTAL (South)		R-50 to R-101	-0.59
TOTAL (Project)		R-1 to R-4, R-50 to R-101	-0.59

Relative sea level (RSL) refers to the local elevation of the sea with respect to land, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. It is anticipated that sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future sea-level change on design, construction, operation, and maintenance of coastal projects, USACE has provided guidance in the form of an Engineering Regulation, ER 1100-2-8162 (USACE, 2013).

ER 1100-2-8162 provides both a methodology and a procedure for determining a range of sea-level rise estimates based on the local historic sea-level rise rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance, a Baseline (low) estimate which is based on historic sea-level rise and represents the minimum expected sea-level change; an intermediate estimate; and a high estimate representing the maximum expected sea-level change. Using equations in ER 1100-2-8162, the baseline, intermediate, and high sea-level rise values were estimated over the life of the project.

The Flagler project area is located approximately 60 miles from National Ocean Service (NOS) gage #8720218 at Mayport, Florida. The historical sea-level rise rate taken from this gage was determined to be 2.4 mm/year (0.0079 feet/year) (<http://tidesandcurrents.noaa.gov/sltrends/index.shtml>).

In order to provide a more accurate estimate of local vertical land motion, the historical sea-level rise rate is adjusted to account for regional trends. The local, adjusted sea-level rise (e+M) at this location becomes 2.29 mm/year (0.0075 feet/year) (<http://www.corpsclimate.us/ccaceslcurves.cfm>).

Given a project base year of 2016 and a project life of 50 years, a table of sea-level change rates was produced for each of the three required scenarios. **Table 3-2**

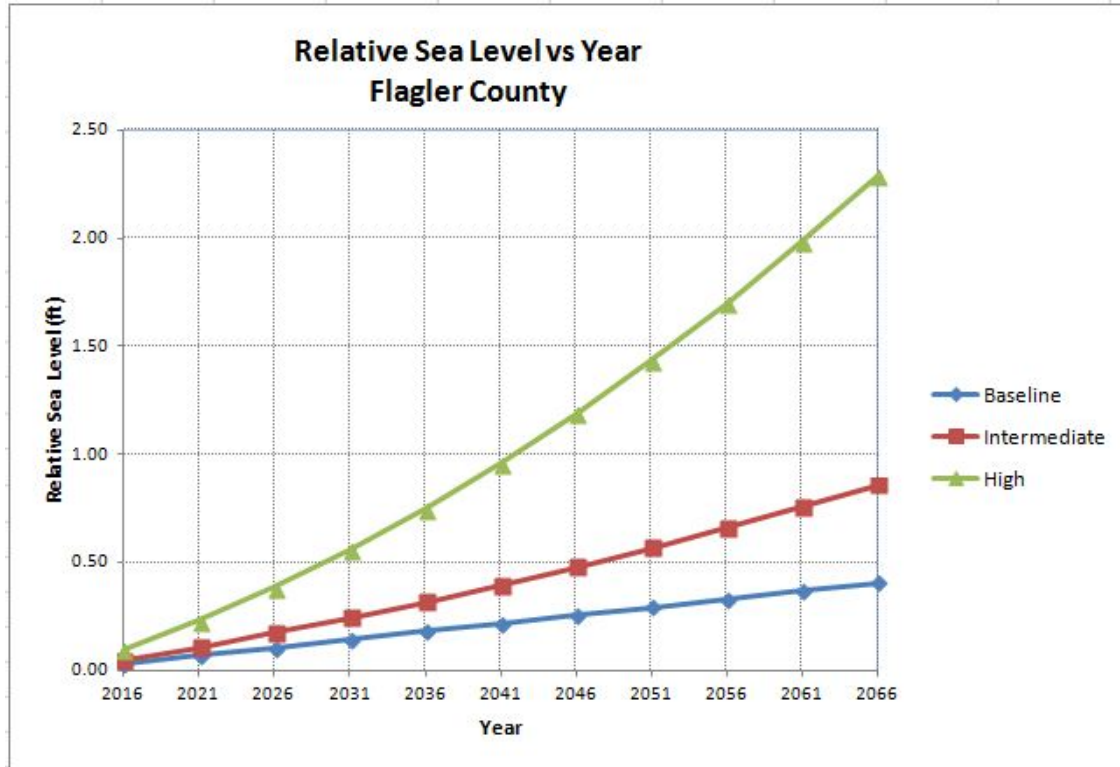


shows the sea-level change rates in five-year increments, starting from the base year of 2016.

**Table 3-2: Relative Sea Level vs Year – Flagler County**

	Baseline (Historic)			Intermediate (NRC Curve I)			High (NRC Curve III)		
	Year	mm	ft	Year	mm	ft	Year	mm	ft
Base Year	2016	9.16	0.03	2016	13.93	0.05	2016	29.05	0.10
	2021	20.61	0.07	2021	32.56	0.11	2021	70.44	0.23
	2026	32.06	0.11	2026	52.55	0.17	2026	117.49	0.39
	2031	43.51	0.14	2031	73.89	0.24	2031	170.18	0.56
	2036	54.96	0.18	2036	96.59	0.32	2036	228.53	0.75
25 Year	2041	66.41	0.22	2041	120.64	0.40	2041	292.52	0.96
	2046	77.86	0.26	2046	146.04	0.48	2046	362.17	1.19
	2051	89.31	0.29	2051	172.81	0.57	2051	437.46	1.44
	2056	100.76	0.33	2056	200.92	0.66	2056	518.41	1.70
	2061	112.21	0.37	2061	230.39	0.76	2061	605.00	1.98
50 Year	2066	123.66	0.41	2066	261.22	0.86	2066	697.25	2.29

**Figure 3-1** shows the three levels of projected future sea-level rise for the life of the project. From these curves, the average baseline, intermediate, and high sea-level rise rates were found to be 0.0075 feet/year, 0.0159 feet/year, and 0.0424 feet/year, respectively. **Engineering Appendix A** provides additional information regarding shoreline response in the project area as a result of SLC.



**Figure 3-1: Relative Sea Level Rise, Flagler County**

The local rate of vertical land movement is found by subtracting the regional MSL trend from local MSL trend. The regional mean sea-level trend is assumed equal to the eustatic mean sea level trend (a uniform worldwide change in sea level rate) of 1.7 mm/year. Therefore in Flagler County, there is 0.59 mm/year of subsidence.

In compliance with ER 1100-2-8162, Beach-fx was configured and run for each sea-level rise scenario in order to estimate the future without-project condition damages. The results are included in Section 3.4.

### 3.3 Incorporation of ER 1100-2-8162: Guidance for Sea Level Change

The draft Sea-Level Change (SLC) Civil Works Technical Letter (CWTL) supporting ER 1100-2-8162 suggests a tiered analysis to determine the risk of potential SLC and resulting incorporation into the plan formulation process. Incorporation of potential SLC into the USACE Planning process will require active focus on risk-based scoping to define pertinent needs, opportunities, and the appropriate level of detail for conducting investigations. In particular, close attention is needed at the beginning of each study in order to screen planning/scoping decisions. The tiered analysis for SLC is incorporated into the 6-step planning process used in this report.

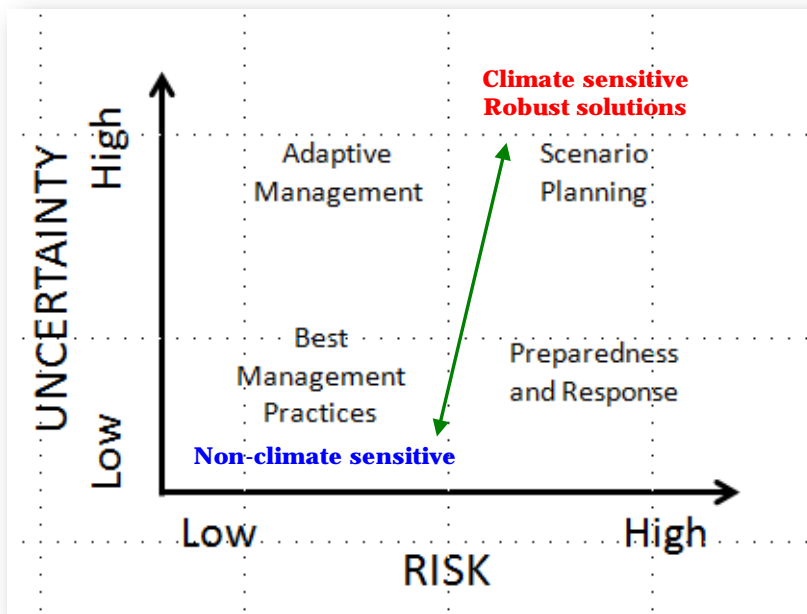
In order to evaluate SLC impacts to infrastructure, critical resources, and the population residing in the study area, a qualitative matrix was developed in **Table 3-2**. Resources evaluated in the matrix were based on those identified by the USACE Coastal Systems Portfolio Initiative (CSPI). CSPI describes the resource risk in a project area relative to the density of the resource, the population density that the resource serves, or in the case of environment/habitat and recreation, the value placed on the resource. See <http://projects.rsm.usace.army.mil/CSPI> for more information.

The qualitative matrix shown in **Table 3-3** evaluates the resources on which the study area depends. In addition to the CSPI evaluation criteria, **Table 3-3** evaluates the vulnerability to resources from potential SLC, or Sea-Level Rise (SLR) in the case of the study area. Averaging the “Vulnerability from SLR” to resources gives an average of 1.2, equating to a relatively low vulnerability of resources. This indicates that SLR is not a major contributor to overall resource vulnerability within the 50-year period of analysis.

**Table 3-3: Qualitative Matrix describing vulnerability of resources from potential accelerations in SLC**

Resource	Risk Rating from CSPI - Value or density of resource or dependent population (3=high, 2=med., 1=low, X=none present)	Description	Vulnerability from SLR (3=high, 2=med., 1=low, X=none present)	Description
Residential/commercial structures	2	Mostly residential (single-family homes) and commercial structures. Approximately 50% of the project area is currently protected by revetment or seawall of varying quality. Most ground floor elevations of structures are 14 feet above existing Mean Sea Level (MSL).	1	Projected high scenario SLC would not place Mean Sea Level (MSL) near infrastructure within the 50 year planning horizon and would increase the flood frequency very minimally. Typical surge experienced in the project area from large coastal storms is between 2 and 4 feet. This indicates that SLR is not a major contributor to future damages over the 50 year planning horizon.
Environment and Habitat	3	Beach/dune habitat. Fairly narrow, steep beach backed by average 18.5 feet high dunes. Where no dune exists, revetments or seawalls of varying quality have been constructed.	2	Beach berm and dune system is located between 10.5 and 18.5 feet above MSL. Sub aerial habitat is located throughout this system.
Infrastructure (roads, water/sewer lines, boardwalks, navigation structures)	2	Water/sewer lines, septic tanks, revetment and dune walkovers exist. State Road A1A is located approximately 14 feet above MSL. Most other infrastructure would not be impacted until water level, including storm surge, reached above this point. The 10-year return period storm tide level is equal to 4 feet.	1	By the end of the 50 year planning horizon, State Road A1A remains adequately elevated above MSL under any SLC scenario. Even under the high SLC scenario, a 12-foot difference would remain between MSL and A1A.
Critical Facilities (police, fire, schools, hospitals, and nursing homes)	1	low density of critical facilities	1	Elevation of most critical facilities remains above MSL under any SLC scenario by the end of the 50-year planning horizon.
Evacuation Routes	3	State Road A1A is main north/south evacuation route, located approximately 14 feet above MSL.	1	By the end of the 50 year planning horizon, State Road A1A remains adequately elevated above MSL under any SLC scenario. Even under the high SLC scenario, a 12-foot difference would remain between MSL and A1A.
Recreation	3	significant recreational use of beaches and fishing pier	1	Beach berm is approximately 10.5 feet above current MSL. Recreational use of beach is high. Fishing pier deck is approximately 25 feet above current MSL. Projected high SLC scenario would not impact the pier within the 50-year planning horizon.
		average =	<b>1.2</b>	<b>Low Vulnerability</b>

Overall, the initial analysis above indicates that the project area vulnerability to SLC is relatively low. However, elevations within the project area (Atlantic Ocean side of the island) are some of the highest on the barrier island, about 15 to 20 feet above Mean Sea Level (MSL). The profile of the island slopes downward from these elevations to the landward side (marsh side) of the island where the lowest elevations of infrastructure are around 2 to 10 feet above current MSL. The island profile is shown in **Figure 3-3**. Marsh side areas of the island will likely be impacted by inundation more frequently than the ocean side as sea level rises, especially during extreme high tide events. A relatively low risk from SLC to the project area combined with high uncertainty over potential accelerations in the rate of SLC lead to an adaptive management strategy as shown in **Figure 3-2**.



**Figure 3-2: Consideration of risk and uncertainty in climate change related decision-making**

In the project area, the oceanfront area covered from MHW to 400 feet inland adequately covers the area impacted by erosion, inundation, and wave attack through a 50-year period of analysis under the high SLC scenario. The majority of the oceanfront area is fronted by 18-foot high dunes relative to NAVD88 according to surveys carried out by the Florida Department of Environmental Protection (FDEP) at coastal range monuments (R-monuments) and 2004 LIDAR data. These surveys typically extend from the dune crest toward the ocean and do not cover the back-bay side of the barrier islands. However, LIDAR data from 2009 was available for the back side of the island and, in combination with the 2004 data, was used to create **Figure 3-3**.

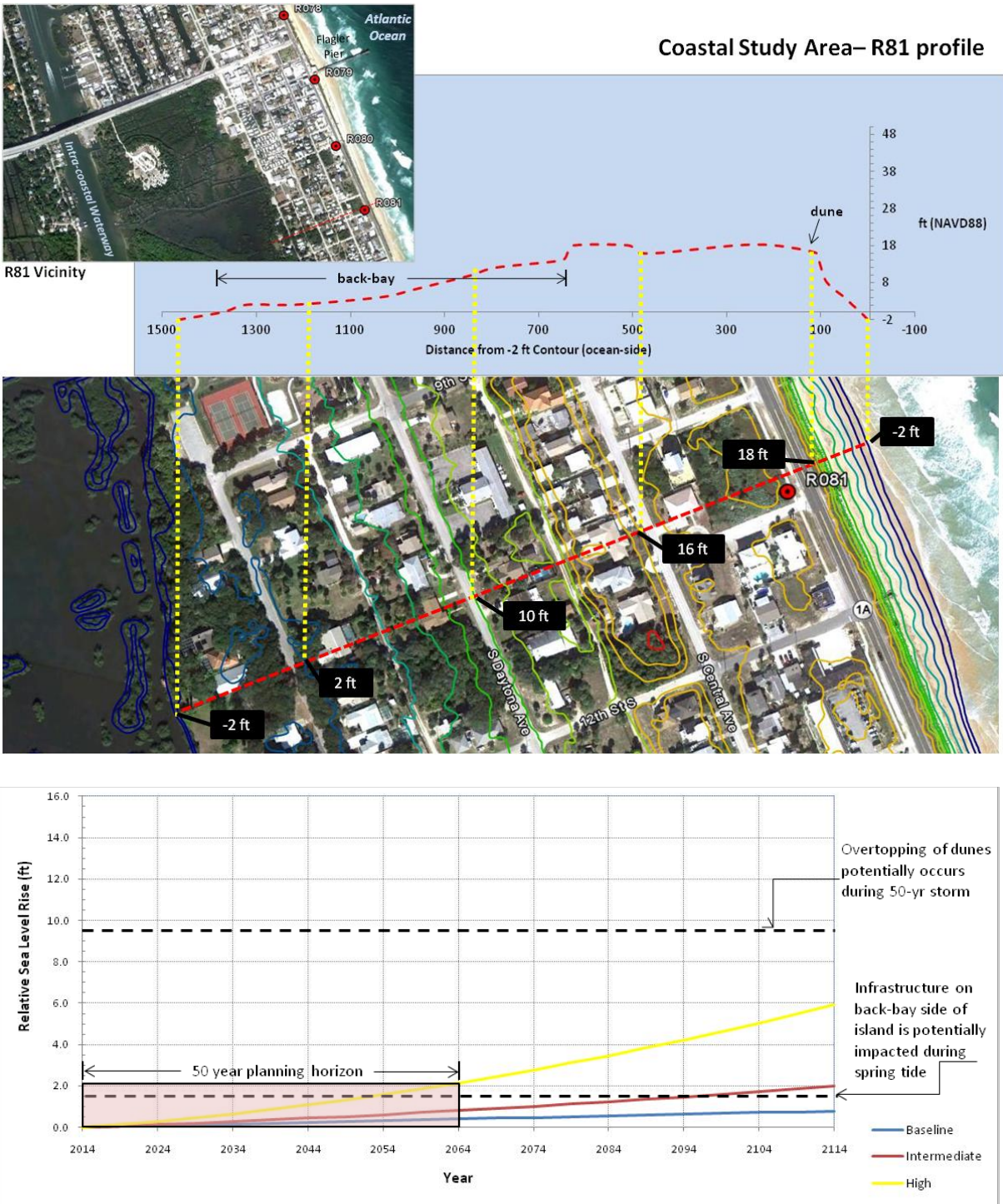


Figure 3-3: Project area profile (R-81 vicinity) and threshold analysis

A key question when assessing the vulnerability of the project area to SLC is when critical thresholds will be crossed, if at all, by potential SLC. **Figure 3-3** has two thresholds depicted, one on the seaward side of the barrier island on which the project area is located and one on the back-bay side of the island, outside of the project area.

Throughout the project area, the dune crest height represents a critical threshold. State Road A1A is located at roughly this elevation and most infrastructure (including single family homes, businesses, etc.) are located at, or above, this elevation.

Mean Sea Level (MSL) is 0.33 feet lower than 0 feet NAVD88 on the ocean side of the island as shown in **Table 3-4**, and 0.27 feet lower than 0 feet NAVD88 on the back-bay side of the island as shown in **Table 3-5**.

**Table 3-4: Tidal datums for Flagler County Study Area (Atlantic Ocean)**

State Road A1A Bridge over Matanzas Inlet (NOS bench mark #8720692)		
	meters (m)	feet (ft)
Mean Higher High Water (MHHW)	1.26	4.12
Mean High Water (MHW)	1.16	3.80
North American Vertical Datum of 1988 (NAVD88)	0.70	2.28
Mean Tide Level (MTL)	0.61	1.98
Mean Sea Level (MSL)	0.59	1.95
Mean Low Water (MLW)	0.05	0.16
Mean Lower Low Water (MLLW)	0.00	0.00

**Table 3-5: Tidal datums for Flagler County back-bay side of barrier island, outside of study area (Intracoastal Waterway)**

Smith Creek, Flagler Beach (NOS bench mark #8720833)		
	meters (m)	feet (ft)
Mean Higher High Water (MHHW)	0.33	1.08
Mean High Water (MHW)	0.29	0.94
North American Vertical Datum of 1988 (NAVD88)	0.24	0.78
Mean Tide Level (MTL)	0.16	0.52
Mean Sea Level (MSL)	0.15	0.51
Mean Low Water (MLW)	0.02	0.07
Mean Lower Low Water (MLLW)	0.00	0.00

The maximum 50-year storm tide elevation in the study area is given as 8.37 feet NAVD88 in Chapter 2. To be conservative, the maximum was used. Combined total storm tide includes contributions of wind stress, barometric pressure, dynamic wave set-up and astronomical tide. Water elevations during such storm events could reach the top of the dunes (18 feet NAVD88 in **Figure 3-3**) once sea level increases by about 9.5 feet (8.37 feet storm tide + 9.5 feet sea level increase  $\approx$  18 feet). This estimate does not take erosion of the dune height into consideration which could occur over time. However, based on past local practice, it can be reasonably assumed that efforts will be made to maintain the dune at its current elevation to protect Highway A1A. At the end of 50 years, sea level may increase by 2 feet under the high SLC scenario, 7.5 feet below the threshold.

The draft CWTL recommends that systems related to, but existing outside, the project area should also be evaluated for vulnerability to SLC. Vulnerability of the back-bay of the island was evaluated to inform the sponsor and to determine if there would be incidental effects on the project area. SR A1A is the main hurricane evacuation route running north and south along the island. In an evacuation event, the vulnerable population would need to exit the island via a bridge to reach the mainland. The bridge (Highway 100) is located on the backside of the island. However, it is sufficiently elevated. MSL on the back-bay (inland) side of the island is approximately 0.27 feet lower than NAVD88. Infrastructure on the back-bay is generally built at or above 2 feet NAVD88 as seen in **Figure 3-3**. This side of the island is mainly affected by tides, not surge, due to its distance from coastal inlets and subsequent sheltering from most factors contributing to combined total storm tide. Tidal range on the back-bay side of the island is smaller than the ocean side. **Table 3-5** shows that MHHW is recorded as 0.3 feet relative to NAVD88.



Infrastructure could be periodically impacted once sea level increases by about 1.7 feet (0.3 feet + 1.7 feet sea level increase = 2 feet). The low and medium scenarios are not expected to increase by this much within the 50-year planning horizon as seen in **Figure 3-3**. However, the high scenario is predicted to surpass this threshold in approximately 40 years after the base year. If the sea level rise rate increases to the high scenario, infrastructure on the back side of the island could be impacted during higher high tide events (spring tide events), dependent on current and future construction to protect against elevated water levels such as seawalls and bulkheads. SLC should be monitored in order to provide adequate lead time to plan for impacts in the case of accelerated SLC.

The existing Coastal Vulnerability Index (CVI) developed by the United States Geological Survey (USGS) is a useful indicator of the project area's natural vulnerability to SLC. Population and infrastructure type, or density, are not parameters used in the assessment. The USGS used six input parameters to assess the CVI for geographic areas along the nation's shoreline. Parameters used include geomorphology, coastal slope, relative SLC, shoreline erosion/accretion, mean tide range, and mean wave height (USGS 2000). **Figure 3-4** shows the CVI for the study area is rated as moderate to high based on the area being part of an erosional barrier island surrounded by sandy beaches and salt marsh.

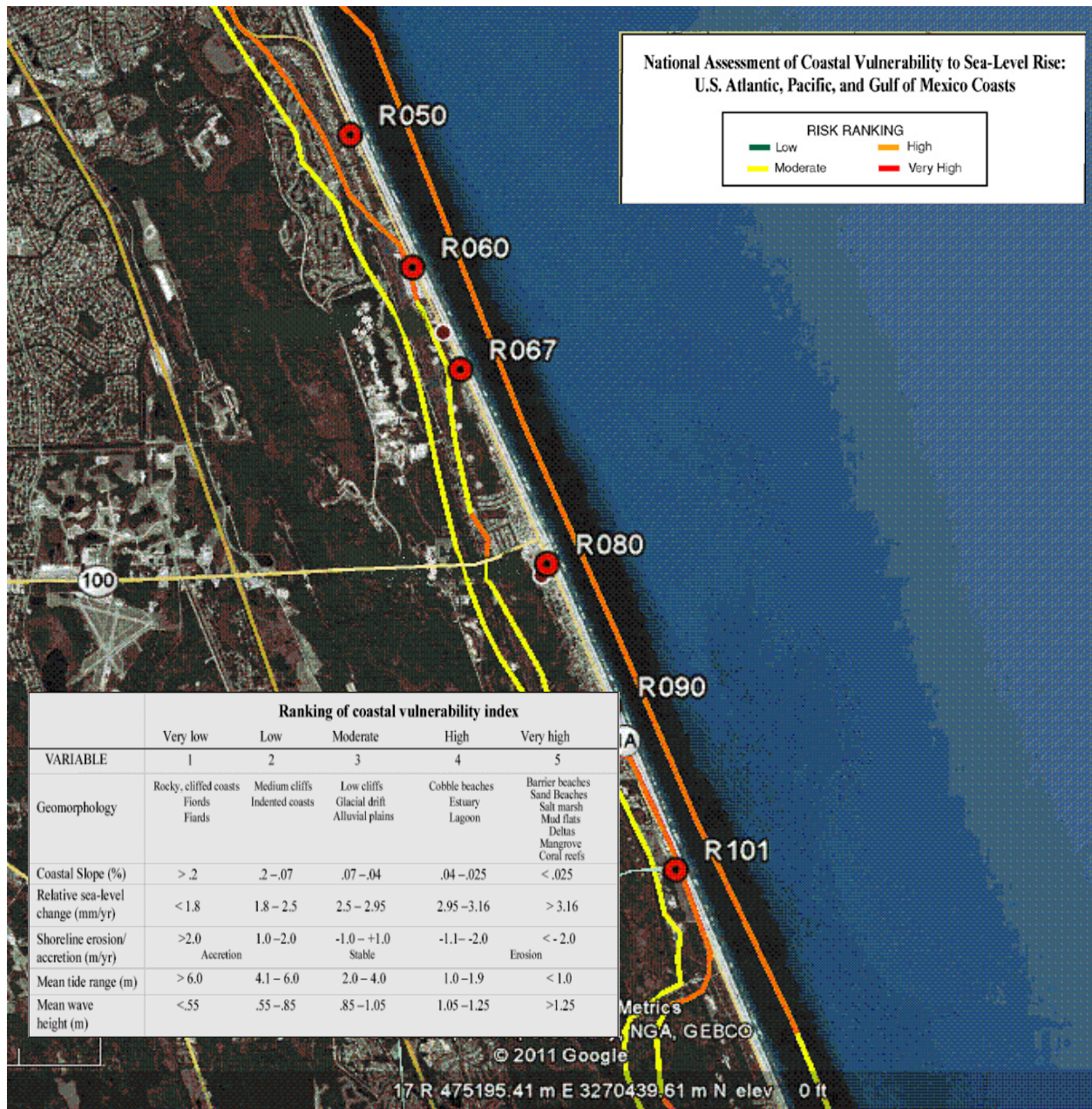


Figure 3-4: USGS Coastal Vulnerability Index.

### 3.4 Property Owner Response

At present, approximately 10% of the project area is protected by some form of constructed shore protection (seawall or revetment). It is projected that additional shore protection measures will be constructed in the future, as allowed by state law, absent a Federal HSDR project in place. With respect to armor, the following assumptions were made:

- Homeowners east of SR A1A whose property is threatened by erosion to within 20 feet of the structure will erect a vinyl sheet pile armoring structure in order to defend their property against damage. This assumption is supported by current practices where homeowners in the Painters Hill reach have been approved by the Florida Department of Environmental Protection (FDEP) to construct vinyl sheet pile armor to ward off erosion.
- The Florida Department of Transportation (FDOT) will continue with measures as necessary to protect SR A1A as described in their 2010 PD&E Study, which states, “FDOT is committed to protecting SR A1A in its existing location, as this road is a hurricane evacuation route, a designated State Scenic Highway (A1A Ocean Shore Scenic Highway), a National Historic Byway, and provides an economic base for the region.” The Flagler Beach reach of the study area contains around 9,000 feet of granite revetment in varying condition that is maintained by FDOT. As SR A1A becomes damaged, FDOT makes repairs to the road and the revetment as required and as funding allows. In recent years, FDOT has most commonly placed rock and sand to protect the road. It is assumed that this type of repair will continue to happen into the future. The FDOT repairs must be within their jurisdictional right of way and in accordance with the Biological Opinion issued by U.S. Fish and Wildlife Service (FWS). The ability of future revetments to withstand coastal storms and erosion is assumed to be similar to that of the existing revetment.
- Homeowners/property owners will continue to add/rebuild armor until their lot is condemned due to erosion.

### 3.5 Economic Analysis

Data on historic storms, beach survey profiles, and private, commercial and public structures within the project area is used as input to the USACE Beach-*fx* model. The model is then used to estimate future project hurricane and storm damages. Beach-*fx* was developed by the Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi. On 1 April 2009 the Model Certification Headquarters Panel certified the Beach-*fx* hurricane and storm damage reduction (HSDR) model based on recommendations from the HSDR - Planning Center of Expertise (PCX). The model was reviewed by the PCX and found to be appropriate for use in coastal storm damage reduction studies. The model links the predictive capability of coastal evolution modeling with project area infrastructure information, structure and content damage functions, and economic valuations to estimate the costs and total damages under various shore protection alternatives. This output is then used to determine the benefits of each alternative. Beach-*fx* fully incorporates risk and uncertainty, and is used to simulate future hurricane and storm damages at existing and future years and to compute accumulated present worth damages and costs. Storm damage is defined as the damage incurred by the temporary loss of a given amount of shoreline as a direct result of waves, erosion, and inundation caused by a storm of a given magnitude and probability. Beach-*fx* is an event-driven life-cycle model that estimates damages and associated costs over a 50-year period of analysis based on storm probabilities, tidal cycle, tidal phase, beach morphology and many other factors. Damages or losses to developed shorelines include buildings, pools, patios, parking lots, roads, utilities, seawalls, revetments, bulkheads, replacement of lost backfill, etc., all classified as “damage elements.” Beach-*fx* also provides the capability to estimate the costs of certain future measures undertaken by state and local organizations to protect coastal assets. Preliminary Beach-*fx* reaches were designated within each study reach. **Figure 3-5** depicts how the reaches correspond to FDEP R-monuments along the coast.

Flagler County Reach Designations and Alignments		
FDEP R-monument	Study Reaches	Preliminary Beach-fx Reaches
R-1	MarineLand	ML-1 to ML-
R-2		
R-3		
R-4		
No reaches between R-4 and R-50		
R-50	Painter's Hill	PH-1 to PH-10
R-51		
R-52		
R-53		
R-54		
R-55		
R-56		
R-57		
R-58		
R-59		
R-60	Beverly Beach	BB-1 to BB-5
R-61		
R-62		
R-63		
R-64		
R-65		
R-66		
R-67	Flagler Beach	FB-1 to FB-31
R-68		
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R-70		
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R-74		
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R-76		
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**Figure 3-5: Reach designations and alignment**

For economic analysis purposes, the future structural inventory and values are the same as the existing condition. This conservative approach neglects any increase in value due to future development. Due to the uncertainty involved in projections of future development, using the existing inventory is preferable and considered conservative for Florida where coastal development has historically increased in density and value. Although newer construction may have a higher value, there may not be more value at risk due to updated construction standards and fewer damageable elements exposed to erosion, inundation, and wave attack.

Assumptions based on data and experience is used in Beach-fx in order to determine actions that effect damages in the future conditions. **Table 3-6** presents general assumptions used in Beach-fx for this study. Additional detail is presented in the **Economic Appendix C**.

**Table 3-6: General Beach-fx Assumptions for Flagler County, Florida**

Flagler County, FL Hurricane and Storm Damage Reduction Project	
Selected Beach-fx Assumptions	
Assumption	Explanation
<b>Storms</b>	
<b>Storm Suite</b>	The Plausible Storm Suite is based on actual historical tropical and extra-tropical storms that impacted the study area between 1887 and 1999.
<b>Storm Probability</b>	Storm Probability parameter was defined as the ratio between number of storms and total number of years in the storm record.
<b>Nourishment</b>	
<b>Emergency Nourishment</b>	Emergency Nourishment was not specified in the model because Flagler County has no historic record of emergency nourishment.
<b>Beach Profile</b>	Six (6) distinct profiles were created in accordance with the natural variations on the beach and dune system. Profile criteria (dune height, dune width, berm width, etc.) were all set according to an adaptation (simplification) of the most recent beach surveys taken in 2007.
<b>Reaches</b>	
<b>Reach Specification</b>	Fifty (50) different reaches were created in approximately 1,000 feet increments, centered on survey monuments (R-monuments) that were established by Florida Department of Environmental Protection. Each reach is assigned a beach profile, created as described in the "Nourishment" section.
<b>Applied Erosion Rate</b>	The Applied Erosion Rate for each Reach was determined by calibrating the model so that many iterations return an average erosion rate that is equivalent to the measured erosion rate of that segment of the project.
<b>Berm Width</b>	It is assumed, based on past shoreline monitoring, that 90% of the berm recovers post-storm.
<b>Back Bay</b>	Back Bay Flooding is not applicable to this study.
<b>Armor</b>	
<b>Armor Type</b>	Coastal armor within the study area was categorized into a number of different types based on construction type, material and elevation. The types of coastal armor were: granite revetments, precast concrete panel sea walls, steel sheet pile sea walls, and vinyl bulkheads. Within Beach-fx, the armor prevented erosion damage in protected lots. In order to accurately simulate damage to the armor itself, several new damage elements were created. The advantages to this approach include: modeling flexibility, the ability to account for gradual, incremental damage, and the ability to account for uncertainty in armor performance. More information about the modeling approach for armor is provided in the Economics Appendix.
<b>Damage Elements</b>	A total of 310 individual damage elements were created, of 17 different types
<b>Foundation Type</b>	Data were collected from the Flagler County Property Appraiser's Office. Foundation types for structures in the study area were predominately one of three types: 1) Concrete Perimeter Footing (i.e. slab), 2)Pilings (deep or shallow), 3)Piers and Posts.
<b>Construction Type</b>	Construction type data were also collected from the Flagler County Property Appraiser's Office. Construction types within the study area were one of two types: 1) Wood; or 2) Masonry
<b>Number of Rebuild Times</b>	The number of possible rebuild times varied depending on the structure.
<b>Structure Values</b>	Replacement cost minus depreciation values were calculated for each structure by Real Estate, Jacksonville District Corps office.
<b>Content Values</b>	Content values were based on Content-to-Structure value ratios (CSVs). The CSVs were assumed to be 0.5 for all residential and commercial structures.
<b>Future Development</b>	For modeling purposes, no future development was assumed in the structure inventory. Within Beach-fx, the structures and their values are the same in the FWOP as they are in the existing condition. This is a conservative assumption in the sense that development does not depend on speculative future development. It also means that the analysis is not implicitly inducing development in the FWOP.
<b>Structure Elevation Data</b>	SAJ contracted a surveyor to estimate the first floor elevations of all structures in the study area. The elevation of these structures was surveyed to an accuracy of +/- 0.5 feet.
<b>Modeling</b>	
<b>Number of Iterations</b>	100 iterations were used. This number provides stable simulation with negligible variability in output.
<b>Discount Rate</b>	3.500%
<b>Sea Level Rise</b>	Sea Level Rise estimates for Low, Mid, and High scenarios were developed in accordance with ER 1100-2-8162.

In order to model damages in Beach-fx, the team developed site specific damage functions for wave attack, inundation and erosion. The team was also required to develop armor failure thresholds in order to calculate armor damage. The most recently developed damage functions (which incorporated both roads and its protective revetment), were calibrated based on empirical data provided by the Florida Department of Transportation for the damages resulting from model runs versus the damage repair costs historically realized. These damage functions and this method of simulating armor damage were coordinated with the Coastal and Hydraulics Laboratory (CHL) and the Coastal Planning Center of Expertise (PCX).

The A1A armor maintenance damages modeled during the first 10 years of the simulation (2013-2023) are within the modeling tolerance of the actual costs incurred by FDOT for maintaining the road from 2000-2010. It is only after 2027 in the model that without-project damages start to increase dramatically. Only after the cumulative effects of storms, sea level rise, and erosion over time begin to take their toll does the model begin to show significant damage. Model results indicate that the future without-project damages are likely to increase significantly in the mid to late 2020s, decrease somewhat by around 2050, but remain relatively high for the remainder of the period of analysis. See the **Economics Appendix** for more details.

**Table 3-7** provides a summary of the results from Beach-fx for the future without-project condition by reach for the low, intermediate, and high SLC scenarios.

**Table 3-7: Future Without Project Present Value Damages for SLC scenarios.**

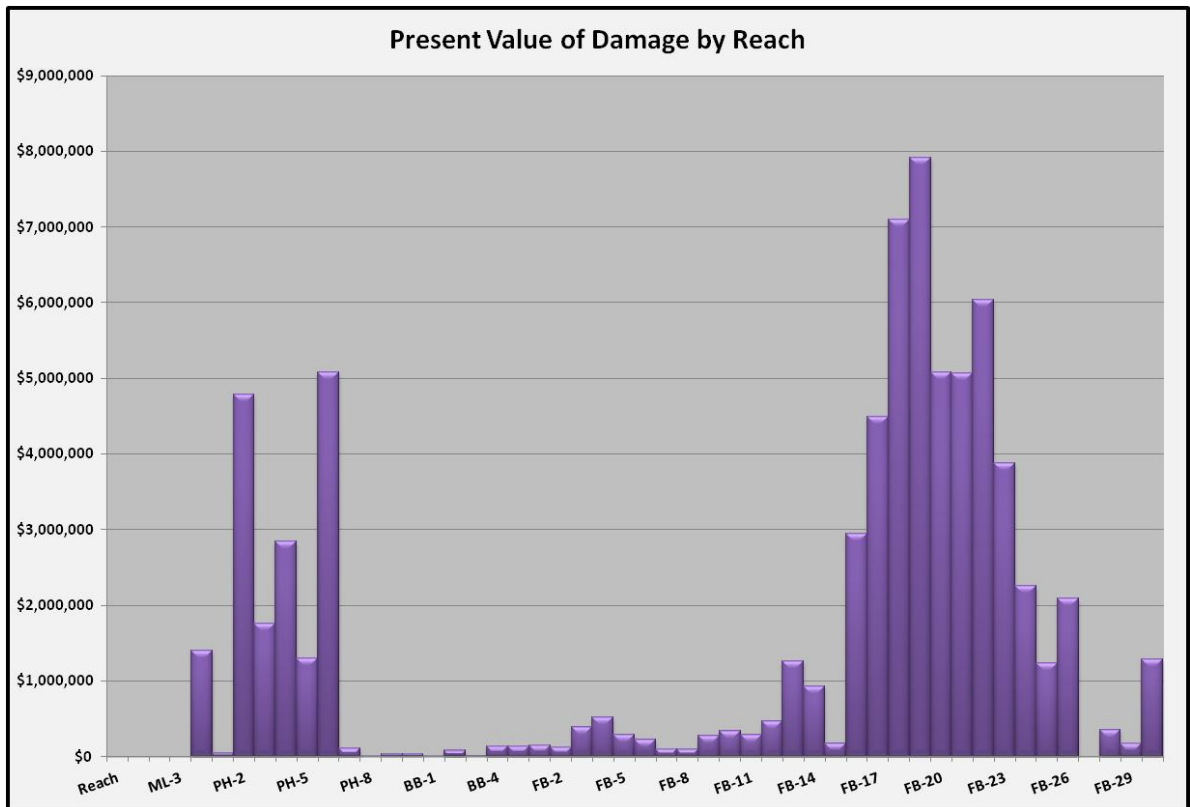
Present Value Damages for baseline, intermediate, and high SLC scenario			
Study Reach	Baseline (low) SLC Scenario	Intermediate SLC Scenario	High SLC Scenario
Marineland	\$1,396,178	3,941,899	\$5,746,220
Painters Hill	\$16,012,271	22,673,505	\$26,630,026
Beverly Beach	\$379,170	4,168,906	\$10,118,431
Flagler Beach	\$55,725,961	112,688,503	\$182,917,865
<b>Total</b>	<b>\$73,513,580</b>	<b>\$143,472,813</b>	<b>\$225,412,542</b>

\* FY13 price level and discount rate

**Figure 3-6** shows damages for the future without-project condition under the baseline SLC condition, breaking the data down to Beach-fx reaches. From this figure and **Table 3-7**, it can be seen that the majority of damages occur in the Flagler Beach reach.

The future without project damages will be used as a base condition against which potential alternatives for storm damage reduction will be measured. The difference between with and without-project damages will be used to determine the benefits of an alternative. Other sources of benefits include recreational benefits and benefits from avoiding land loss.





**Figure 3-6: Future without project present value total damages by preliminary Beach-fx reach (FY13 price level and discount rate).**

Once benefits for each of the alternatives are calculated, they will be compared to the costs of implementing the alternative. Dividing the benefits of an alternative by the costs of the alternative yields a Benefit-to-Cost Ratio (B/C Ratio). This ratio must be greater than 1.0 in order for the alternative to be justified and implementable (i.e., the benefits must be greater than the costs). The federally-preferred plan (NED – National Economic Development Plan) is the plan that maximizes net benefits while protecting the nation’s environment and is socially acceptable. Net benefits are determined by simply subtracting the cost of any given alternative from the benefits of that alternative (Benefits – Costs = Net Benefits). Furthermore, each project area is evaluated on an incremental basis. That is, each portion of the project must be justified independently.

Pursuant to estimating future without-project condition damages and associated costs for the study area in Flagler County, Beach-fx was used to estimate damages and costs in the following categories:

- **Structure Damage:** Economic losses resulting from structures being exposed to wave attack, inundation, and erosion damages.
- **Contents Damage:** The material items within structures (usually air conditioned and enclosed) that are potentially subject to damage.
- **Armor/Road Damage:** Beach-*fx* provides the capability to estimate the costs incurred from measures likely to be taken to protect coastal assets and or prevent erosion in the study area. Based on the existence of coastal armor throughout the study area, Beach-*fx* was used to estimate the costs of erecting such measures throughout the period of analysis. It should be noted that road damages and armor damages are reported in a single damage category. This is due to the fact that State Road A1A (SR A1A) runs adjacent to the beach throughout the study area. SR A1A and the armor that protects it (typically revetment) are inextricably linked. The armor was built specifically to protect the road. And, if the armor is damaged beyond a defined threshold, the road itself can receive damage. Damages to the road and armor, and costs to repair or construct new armor, are reported by Beach-*fx* as a single category, defined in this report as “armor/road” damage. The damage functions and values that were developed are based on existing FDOT data. More information about these damage elements is provided in the economics appendix.
- **Land Loss Value:** The estimated land loss value associated with erosion is based on land loss estimates from Beach-*fx* and nearshore land values provided by USACE Jacksonville District (SAJ) real estate personnel.

**Table 3-8** provides detail on the accumulated present value damages and cost calculated for the Flagler County study area by category.

**Table 3-8: Future Without Project Damages by Category (Present Value),**

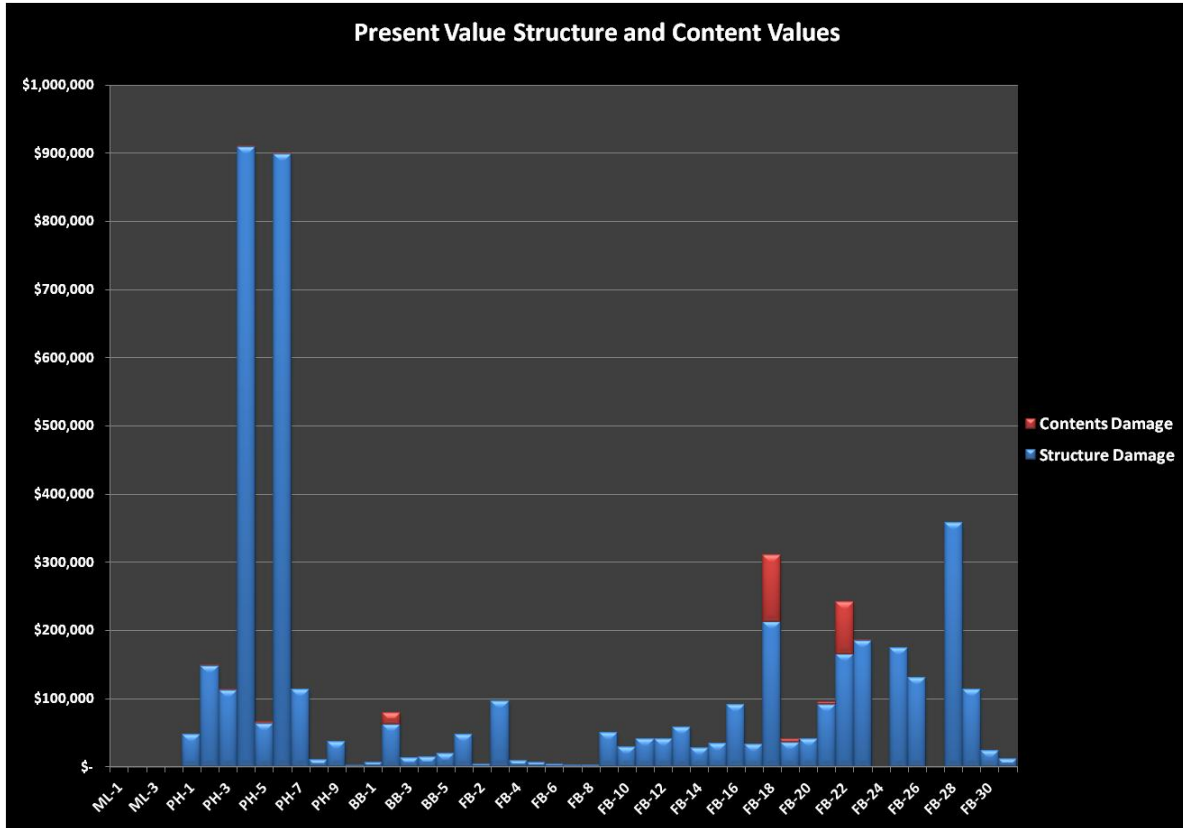
Area	Structure Damage	Content Damage	Armor and Road Damage	Total Costs and Damages
<b>Marineland</b>	\$ -	\$ -	\$ 1,396,178	\$ 1,396,178
<b>Painters Hill</b>	\$ 1,999,405	\$ 343,693	\$ 13,669,173	\$16,012,271
<b>Beverly Beach</b>	\$ 117,392	\$ 16,927	\$ 244,849	\$ 379,169
<b>Flagler Beach</b>	\$ 2,079,098	\$ 182,763	\$ 53,464,100	\$55,725,961
<b>Total</b>	<b>\$ 4,195,895</b>	<b>\$ 543,384</b>	<b>\$ 68,774,300</b>	<b>\$ 73,513,579</b>
<b>Percent of Total Costs and Damages</b>	<b>6%</b>	<b>1%</b>	<b>94%</b>	

\* FY13 price level and discount rate

There is a great deal of variability in the amount of damages among the project reaches. This is explained by the large number of variables, all of which the Beach-*fx* model takes into account. Examples of variation result from the following:

- Density and amount of development
- Typical size and value of structures
- Typical distance between structures and mean-high water
- Size, shape and location of the dunes and coastal morphology
- Rate of erosion for each reach
- Amount and type of coastal armoring present
- Eligibility of homeowners to construct coastal armoring

In **Table 3-8**, structure and content damages comprise nearly 7% of the total estimated future economic losses. **Figure 3-7** depicts structure and content damages throughout the study area.



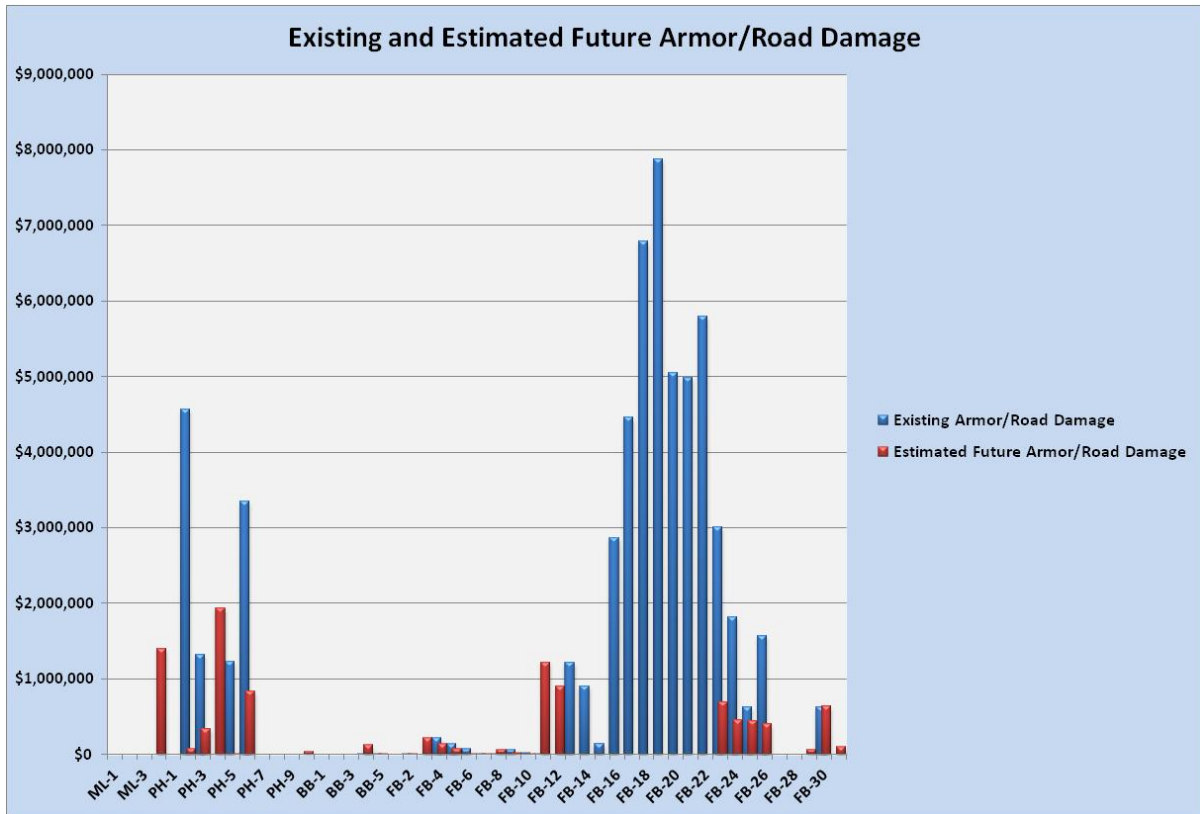
**Figure 3-7: Future Without Project Structure and Content Present Value Damages by Preliminary Beach-fx Reach (FY13 price level and discount rate).**

Painters Hill and Beverly Beach have a mix of newer and older residential structures and vacant lots seaward of SR A1A. Some of the structures are designated not “armorable” in the future due to their location relative to the coastal construction control line (CCCL) and the construction dates of structures according to parcel data. Structures built seaward of the CCCL after 1988 are designated not “armorable” in the future. Thus, residences seaward of A1A that may acquire armor are scattered among those that may not. Even though SR A1A is assumed to be “armorable” in the future based on recent and past occurrences of FDOT taking measures to rebuild and protect the road, the presence of armored and unarmored lots seaward of the road prolongs the damage elements’ exposure to erosion damage driving parameters.

For purposes of economic analysis vacant lots were assumed “unarmorable” in the future since it is also assumed that vacant lots will remain undeveloped.

Armor damages and costs throughout the period of analysis are estimated to be 93% of total damages and costs for the study area in the future without project condition. The majority of the armor costs are incurred protecting SR A1A, particularly in Flagler Beach. **Figure 3-8** shows damages to existing armor and

costs to build future armor throughout the study area over the 50-year period of analysis. It is evident from this figure that the majority of existing and future armor impacts are located in the Flagler Beach reach. Any potential Federal project will most likely be justified by preventing these damages and future costs to repair/construct a new revetment protecting SR A1A.



**Figure 3- 8: Costs to rebuild present armor inventory (blue) and costs to construct new armor (red) by Preliminary Beach-fx Reach (FY13 price level and discount rate).**

FDOT plans to maintain A1A in its current location. However, if the existing SR A1A revetment is not maintained, it will be impossible to maintain the road. Over time, the road would absorb significant erosion damage. Eventually the structures and property located on the landward side of the road would also receive damage. Within the Flagler Beach Study Area, where A1A is the most seaward damage element from R-60 through R-94, there are 490 single-family structures, 87 multi-family structures, and 104 commercial structures located landward of A1A. The road and road armor is not a protective feature that provides benefits for protecting landward structures. The road and road armor is modeled as a damage element. In the intermediate and high sea level rise scenarios (SLR1 and SLR2), the road would be destroyed earlier and the damage elements behind the road would receive significantly more damage if the road and armor were not maintained.

3.6 Environmental Resources \*

3.6.1 General

The majority of the existing environmental and historic resources discussed in Chapter 2 are not predicted to significantly change during the 50-year period of analysis of the future without-project condition. A major stressor in the future without-project condition will be the continued erosion of the berm and dune system and projected responses from property owners. The beach berm and dune width will be reduced and there will be an increase in shore armoring as structures are threatened by coastal storms. The projected reduction in berm width is most likely to adversely affect sea turtles and shorebirds.

3.6.2 Specific

**Table 3- 9** provides details of the environmental effects of the future without-project conditions.

**Table 3- 9: Summary of Direct and Indirect Impacts.**

EXISTING ENVIRONMENTAL FACTOR	ALTERNATIVE No Action
VEGETATION	Continued erosion of the dune and upper beach will further stress dune vegetation causing die-back of species.
PROTECTED SPECIES	Continued loss of sea turtle nesting habitat on the beach.
HARDBOTTOM RESOURCES	No reasonably foreseen impacts would occur. Known hardbottom resources occur within the study area but do not occur within the proposed project limits.
FISH AND WILDLIFE RESOURCES	Continued loss of dune and beach habitat.
ESSENTIAL FISH HABITAT	No reasonably foreseen impacts would occur.

<b>EXISTING ENVIRONMENTAL FACTOR</b>	<b>ALTERNATIVE No Action</b>
COASTAL BARRIER RESOURCES	Continued loss of beach habitat associated with CBRA Units FL-P07P and P05A.
WATER QUALITY	No reasonably foreseen impacts to water quality would occur.
AIR QUALITY	No reasonably foreseen impacts would occur.
NOISE	No reasonably foreseen impacts would occur.
AESTHETIC RESOURCES	Long-term decline in appearance of the beach as it continues to erode.
RECREATION RESOURCES	Long-term decline in beach available for use by recreational interests.
NAVIGATION	No reasonably foreseen impacts would occur.
HISTORIC AND CULTURAL RESOURCES	Long term shoreline encroachment will impact historic properties immediately adjacent to the shoreline.
NATIVE AMERICANS	No adverse effects to Native American properties.

# CHAPTER 4

## PROBLEMS AND OPPORTUNITIES

### PROBLEMS

Storm waves, inundation and erosion threatens:  
Coastal Structures and Infrastructure including  
Highway A1A  
Natural Habitat  
Recreational Opportunities

### OPPORTUNITIES

Reduce Storm Damage to Structures and Infrastructure  
Restore Dunes  
Protect Habitat  
Protect Evacuation Route (Highway A1A)  
Maintain Recreation

### PLANNING OBJECTIVES

Reduce Storm Damages to Structures and Infrastructure  
Maintain Environmental Quality  
Maintain Recreational Opportunities  
Maintain an Evacuation Route

### FEDERAL OBJECTIVES

National Economic Development  
Environmental Quality  
Other Social Effects  
Regional Economic Development

### PLANNING CONSTRAINTS

Avoid Conflict with Federal/State/Local Regulations  
Avoid, and If Not Able To Avoid, Minimize and Mitigate Environmental Impacts





FLAGLER COUNTY, FLORIDA  
HURRICANE AND STORM DAMAGE REDUCTION PROJECT  
FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

**CHAPTER 4**  
**PROBLEMS AND OPPORTUNITIES**

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\* Items required for an Environmental Assessment by the National Environmental Policy Act

## 4 PROBLEMS AND OPPORTUNITIES

### 4.1 Agency and Public Concerns \*

#### Scoping

During formulation and evaluation of the project, input from environmental agencies and the public was facilitated through numerous means, including the following:

- A scoping letter to all Federal and state agencies, local libraries and agencies, and all abutting property owners on August 26, 2008
- A Notice of Intent to prepare a Draft Environmental Impact Statement published in the Federal Register on August 26, 2008
- A public scoping meeting held in Bunnell, Flagler County, Florida on October 25, 2011 in fulfillment of NEPA requirements at which a rich diversity of views were expressed including those for and against a shore protection project

As a result of the August 26 scoping letter, the Florida Department of Environmental Protection (FDEP) indicated that state designated critically eroding areas had been extended in the Painters Hill, Beverly Beach, and Flagler Beach reaches. In response, USACE extended the study area to close the gaps between the three southern study reaches.

A feasibility scoping meeting (FSM) was held by Jacksonville District Planning Division staff to discuss the study on January 28, 2011. One purpose of the FSM was to collect input from affected resource agencies regarding:

- The Future Without-Project anticipated conditions in the study area
- The affect on resources due to expediting the study, with specific reference to the alternatives identified in the Draft Feasibility Study Report and integrated Environmental Impact Statement (now revised as an Environmental Assessment)
- The feasibility study and its key alternatives
- The required depth of analysis, as well as defined study constraints

A study overview was provided by the SAJ District via a web-meeting. Either physical or virtual (via phone conferencing and webinar) attendance at the FSM included representation from the following agencies:

- U.S. Army Corps of Engineers (USACE) Headquarters (HQ), South Atlantic Division (SAD), and Jacksonville District (SAJ)
- Flagler County (Project Sponsor)
- City of Flagler Beach
- Florida Department of Environmental Protection (FDEP)
- Florida Department of Transportation (FDOT)
- Bureau of Ocean Energy Management (BOEM)

- Florida Fish and Wildlife Conservation Commission (FWC)

In addition to those listed above, an invitation to the event included the following agencies:

- U.S. Fish and Wildlife Service (FWS)
- National Marine Fisheries Service (NMFS)
- U.S. Environmental Protection Agency (EPA)

The sponsor and agencies provided their comments and input regarding the study, and important issues identified by the USACE HQ Office of Water Project Review (OWPR) were discussed in detail.

### Issues

The concerns voiced in response to the USACE scoping letter included:

- Potential opportunities to redirect heavy traffic from SR A1A
- Claims that erosion problems in Flagler County are overstated
- Suggestion that the apparent erosion problems are really caused by rainwater runoff and poorly maintained storm drains and there is no need for storm damage reduction
- Desire to maintain the uniquely colored sandy beaches

In addition, significant input was derived from the June 2006 Florida Department of Transportation (FDOT) public workshops soliciting community feedback on an ongoing Project Development and Environment (PD&E) study and related alternatives. The FDOT study focused on plans to protect SR A1A in Flagler Beach. Multiple representatives from various Federal, state, and local agencies and interest groups provided comments, illuminating a wide variety of concerns and recommendations to be considered by state and Federal agencies while planning projects with potential impacts to the coastline and SR A1A.

The ideas and comments offered included the following:

#### Safety Concerns

- Preserving SR A1A
- Limiting truck traffic
- Providing pedestrian access/crosswalks
- Protecting SR A1A from storm surges
- Maintaining SR A1A as an evacuation route

#### Environment

- Preserving the beach naturally
- Protecting the dunes from storm-induced erosion
- Protecting sea turtle habitat and activities

- Preserving the ecosystem

#### Community Issues

- Providing beach access
- Increasing public parking for beach and adjacent businesses
- Maintaining/preserving/enhancing scenic highway and aesthetics
- Creating better and uniform signage
- Preserving the pier located in the Flagler Beach reach
- Improving and preserving the “Old Florida” unique characteristics of downtown (e.g. through zoning, signage and access)
- Maintaining an unobstructed view of the ocean from the roadway

From the FDOT public workshops, a number of ideas for long-term solutions were suggested by attendees. Some of the ideas are listed below:

- Relocate SR A1A
- Designate SR A1A for local traffic only
- maintain the current north/south configuration of SR A1A through Flagler and Volusia counties
- Beach renourishment using a variety of techniques
- Build seawalls
- Construct undercurrent stabilizers, i.e., submerged groins

The following issues were identified to be relevant to the proposed action and appropriate for detailed evaluation:

- Vegetation
- Threatened and endangered species
- Fish and wildlife resources
- Essential fish habitat
- Coastal barrier resources
- Water quality
- Air quality
- Noise
- Aesthetic resources
- Recreation resources
- Navigation
- Historic and cultural resources
- Native Americans
- Socio-economics
- Public safety

#### Conflicts and Controversy \*

No conflicts or controversy regarding this project have been identified.

## 4.2 Problems and Opportunities \*

A problem is an existing undesirable condition to be changed. An opportunity is a chance to create a future condition that is desirable. The difference between problems and opportunities is often indistinct, but in both cases a changed future condition is preferred. The purpose of this feasibility study is to develop an implementable and acceptable plan to improve the future condition and address specific problems and opportunities in the study area. Problems and opportunities to be addressed were identified in several ways. The study team reviewed previous studies by USACE and the Florida Department of Transportation (FDOT), as well as scoping letter comments received from local residents and stakeholders to identify current hurricane and storm damage related problems affecting the study area. Also, USACE has taken into account the outcomes of the public workshops and brainstorming meetings which have been held by FDOT since 2006 to solicit public input regarding storm damage protection along the Flagler Beach shorelines paralleled by SR A1A.

### 4.2.1 Problems

Specific problems in the study area include the following:

- Effects from storms including erosion, storm surge (inundation), and wave attack are causing damage to coastal structures and infrastructure.
- Natural beach habitat of nesting sea turtles, benthic invertebrates, and shore birds is being lost to coastal erosion.
- Shoreline erosion is decreasing beach width, threatening recreational and tourism opportunities.

Beach erosion, both long term and storm induced, is the greatest problem in the study area. Due to the unique beach sediments and proximity of existing coastal development, Flagler County's beaches are experiencing a long-term erosional trend with little natural recovery. Throughout the study area, infrastructure has been developed directly on top of the primary dune system, often depriving the beach from sediment gained from natural dune erosion. Beach and dune width is reduced during storm events as sediments are transported away from the beach and are less likely to be fed back into the upper beach and dune system by aeolian (wind driven) processes due to the sediment grain size and associated relative weight. Therefore, periodic severe storm events are removing sediment from the dune and beach face and the natural processes to replace the sediment are restricted.

Some major concerns voiced by the public relate to the vulnerability of the historic Marineland Oceanarium, the National Scenic Highway SR A1A, and coastal residences. As a result of past coastal storms, homes have been in imminent danger of being undermined and destroyed in the Painters Hill reach. Painters Hill homeowners have applied for permits from FDEP to construct temporary seawalls signifying the severity of the situation. Such permits have been granted by FDEP in

the past, but only in response to severe erosion and on the conditions that structures are temporary and will be removed at some point in the future. In addition, FDOT has been addressing the problem of shoreline erosion threatening SR A1A in Flagler Beach for more than 30 years. FDOT has periodically applied sand fill and replaced lost dune sections with native coquina and granite rock. This method of protecting the roadway is a result of available funding and a construction footprint limited to 50 feet from the centerline of SR A1A. It is estimated that the annual expense to FDOT to maintain the revetment in Flagler Beach is approximately \$600,000/year.

Sea-level rise and projected increases in the frequency and intensity of tropical and subtropical storms are expected to exacerbate the erosion pressures in the study area. Problems associated with the eroding shoreline include impacts to tourism, recreation, and habitat loss.

#### 4.2.2 Opportunities

Opportunities focus on desirable future conditions and potential ways to address the specific problems within the study area. Opportunities that may result from management measures are to:

- Reduce storm damage to coastal structures and infrastructure, and residential and commercial property.
- Restore dunes to function naturally where possible in the study area.
- Protect habitat of nesting sea turtles, benthic invertebrates, and shore birds.
- Protect the current hurricane evacuation route capability in eastern Flagler County.
- Maintain existing recreation and tourism opportunities.

Protecting coastal structures and infrastructure, as well as residential and commercial property from storm damage may be realized by implementing a single management measure or a combination of management measures which may be structural and/or non-structural. Coincident with some management measures like beach nourishment and dune creation/remediation are opportunities to protect natural habitat for sea turtles, shore birds, etc. While some natural functions, such as sea turtle nesting, may be disrupted during construction activities, there is an opportunity for long-term benefits in preserving the beach habitat. Providing hurricane and storm damage reduction benefits in Flagler Beach will help to preserve the current hurricane evacuation route (SR A1A) capability and the economic base for eastern Flagler County. There is also the opportunity to preserve recreational opportunities that the current beach and dune systems provide such as beach access, surfing, fishing, and wildlife viewing. Preserving recreational opportunities provides many benefits to the local economy.

## 4.3 Objectives \*

### 4.3.1 Federal Objectives

The Federal objective, as stated in The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983 (P&G), is to contribute to national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net economic benefits that accrue in the study area and the rest of the nation.

#### 4.3.1.1 Federal Environmental Objectives

The USACE considers carefully and seeks to balance the environmental and development needs of the nation in full compliance with the National Environmental Policy Act (NEPA) and other authorities provided by Congress and the Executive Branch. Public participation is encouraged early in the planning process to define environmental problems and elicit public expression of needs and expectations. Significant environmental resources and values that would likely be impacted, favorably as well as adversely, by an alternative under consideration are identified early in the planning process. All plans are formulated to avoid to the fullest extent practicable any adverse impact on significant resources. Significant adverse impacts that cannot be avoided are minimized and/or mitigated as required by Section 906(d) of the Water Resources Development Act (WRDA) of 1986. This feasibility study describes the environmental impacts of the recommended plan and summarizes compliance with Federal statutes and regulations.

#### 4.3.1.2 Environmental Operating Principles

Consistent with the National Environmental Policy Act (NEPA), USACE has reaffirmed its commitment to the environment by formalizing a set of environmental operating principles applicable to all its decision making and programs. These principles foster unity of purpose on environmental issues and ensure that conservation, and environmental preservation and restoration are considered in all USACE activities.



Sustainability can only be achieved by the combined efforts of federal agencies, tribal, state and local governments, and the private sector, each doing its part, backed by the citizens of the world. These principles help USACE define its role in that endeavor. The USACE Environmental Operating Principles are:

- Foster sustainability as a way of life throughout the organization.
- Proactively consider environmental consequences of all Corps activities and act accordingly.
- Create mutually supporting economic and environmentally sustainable solutions.
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.
- Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs.
- Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.
- Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

#### 4.3.1.3 Federal Project Purposes

Hurricane and storm damage reduction projects have been authorized for a variety of purposes: beach erosion control, shore/shoreline protection, hurricane/hurricane wave protection, and storm protection. The WRDA of 1986 assigns costs of Federal projects to appropriate project purposes. The costs for construction associated with this study area are assigned to either hurricane and storm damage reduction or recreation. Project reaches that provide hurricane and storm damage reduction are assigned a 65% Federal share for initial construction. Specifically for beach renourishment projects, WRDA 1999 assigned a 50% Federal share for future renourishments. Project reaches that provide for separable recreation are not federally cost shared. The Federal government does not participate in any work in separable recreation benefits realized such as constructing a beach only for recreational purposes (and not hurricane and storm damage reduction purposes) or constructing recreation facilities at hurricane and storm damage reduction project site. Recreation is not considered to be a high priority output or primary project output under current Department of Army policy. This policy precludes Federal funds to support construction of shore or hurricane protection projects which depend on separable recreation benefits for economic justification, or for which incidental recreation benefits are greater than 50% needed for justification (ER 1105-2-100 section 3-4.b(4)(a)).

#### 4.3.1.4 Campaign Plan of the U.S. Army Corps of Engineers (USACE)

The USACE Campaign Plan goals and objectives are derived, in part, from the Commander's intent, the Army Campaign Plan, and the Office of Management and Budget. The four goals and their associated objectives also build on prior strategic planning efforts. Each goal and objective is led by a USACE senior leader who manages and oversees actions to reach the goal and objectives.

The successful achievement of the goals and objectives contained in the Campaign Plan are dependent on actions implemented by the entire USACE team. The implementing actions supporting each goal and objective are contained in the headquarters staff and Major Subordinate Command (MSC) implementation guidance for the Campaign Plan. The four goals of the Campaign Plan are:

**Goal 1:** Deliver innovative, resilient, and sustainable solutions to DoD and the nation.

**Goal 2:** Deliver enduring and essential water resource solutions, utilizing effective transformation strategies.

**Goal 3:** Deliver support that responds to, recovers from, and mitigates disaster impacts to the nation.

**Goal 4:** Build resilient People, Teams, Systems and Processes to sustain a diverse culture of collaboration, innovation and participation to shape and deliver strategic solutions.

These Campaign Plan goals and associated objectives will be addressed through the course of the feasibility study.

#### 4.3.2 State and Local Objectives

The State of Florida is empowered by the Federal Coastal Zone Management Act (CZMA) and its implementing regulations in 15 CFR Part 930 to review Federal activities within, or adjacent to, the coastal zone in Florida to determine whether the activity complies with the requirements of the state's approved management program. Florida's Coastal Zone Management Program was established under the Coastal Management Act of 1978 (Chapter 380, Florida Statutes) and approved by the Federal Coastal Zone Management office in 1981. Florida does not regulate its coastal zone through one comprehensive law but rather through 24 state statutes. Through Florida's comprehensive planning act, local governments are also given the opportunity to determine whether these activities are consistent with their goals and policies. The Florida Department of Environmental Protection (FDEP) is the lead state agency for the implementation of the Coastal Zone Management Program.

The Beach and Shore Preservation Act (Chapter 161, Florida Statutes) is Florida's primary statute for developing and implementing the state's strategic beach management plan, regulating coastal construction seaward of the mean high water

line, and regulating activities seaward of the coastal construction control line, defined below. The act, administered by the FDEP, was first passed in 1965 and has since been significantly amended. The objective of the Beach and Shore Preservation Act is to preserve and protect Florida's sandy beaches and adjacent beach and dune systems which serve to protect upland properties from storm damage, provide recreation for Florida residents and visitors, and provide habitat for wildlife. The following paragraphs describe programs which may have a bearing on this study.

#### 4.3.2.1 Coastal Construction Control Lines

In the State of Florida Beach and Shore Preservation Act, the legislature asserted that Florida beaches and coastal barrier dunes are among the state's most valuable natural resources and that these resources should be protected from "imprudent construction which can jeopardize the stability of the beach-dune system, accelerate erosion, provide inadequate protection to upland structures, endanger adjacent properties or interfere with public beach access" (Section 161.053, Florida Statutes). To ensure that such "imprudent construction" does not take place, the statute charged the FDEP to define and establish Coastal Construction Control Lines (CCCL's). The CCCL represents the area of the beach and dune system that is expected to be subject to severe fluctuation from a 100-year storm surge. The specific location of the line is a function of the predicted storm surge and erosion resulting from a 100-year storm. The FDEP has established control lines on a county-by-county basis for Florida's 25 sandy beach counties (Section 161.053, Florida Statutes), including Flagler County. The CCCL defines the FDEP jurisdictional area in which special planning and design criteria are applied to construction and related activities through the permit program. The primary purposes of this permitting program are to ensure that construction seaward of the control line is designed and cited to protect beaches and dunes from adverse impacts and to ensure that construction seaward of the line does not result in accelerated erosion on adjacent land. Coastal storm damage reduction alternatives such as beach restoration and nourishment, dune restoration and maintenance, seawalls, revetments, and groins would be included under the jurisdiction of this program. The FDEP has also implemented a coastal monitoring program for survey and documentation purposes. Control monitoring locations (R-monuments) have been established approximately every 1,000 feet along the coastal shoreline of all beach front areas to serve as monument reference stations during surveying. FDEP regularly conducts post-storm surveys that provide Florida with a comprehensive pre- and post-storm database.

#### 4.3.2.2 Joint Coastal Permit Program

The Beach and Shore Preservation Act regulates construction activities on sovereign lands of Florida seaward of the mean high water line (Chapters 161.041, 373, 253 and 258, Florida Statutes) through the Joint Coastal Permit (JCP) program. This program is a combination of the CCCL regulatory program and the Environmental Regulatory Program, including the water quality certification, authorized under Chapters 373 and 403, Florida statutes. It also covers activities affecting inlets. The program is intended to protect the beach from further erosion, maintain water quality, protect threatened and endangered species habitat, and properly allocate public trust resources. The JCP program regulates activities that could have a material physical effect on coastal processes. Those activities primarily include beach restoration and nourishment projects, erosion control projects (including breakwaters and groins), and coastal inlet management projects (including navigational dredging, sand bypassing, and jetties). The JCP is the vehicle for the Corps' water quality certification under Section 401 of the Clean Water Act, 33 U.S.C. Section 1341, as well as for a finding of consistency with the Florida Coastal Zone Management Program pursuant to Section 307 of the Coastal Zone Management Act.

#### 4.3.2.3 Erosion Setbacks

The 1985 State Comprehensive Growth Management Act (Chapter 85-55, Laws of Florida) amended the Beach and Shore Preservation Act to include a construction setback provision for all sandy beach counties. The amendment prohibits FDEP from granting most coastal construction permits on land that will be seaward of the seasonal high water line within 30 years (Section 161.053, Florida Statutes). The 30-year erosion projection cannot, however, extend landward of an established CCCL (Section 161.053, Florida Statutes). FDEP uses long-term erosion rates to delineate the location of the 30-year erosion projection, considering also the presence of shore protection structures and beach restoration projects (Section 161.053, Florida Statutes). FDEP can grant coastal construction and JCP permits for shore protection structures, piers, and minor structures seaward of the 30-year erosion projection. FDEP can permit construction of a single-family residence seaward of the line only if the parcel was platted before adoption of the amendment, the landowner does not own another parcel adjacent to and landward of the parcel proposed for development, and the structure is located landward of the frontal dune and as far landward as practicable (Section 161.053, Florida Statutes). In addition, repairs or reconstruction of a building cannot "expand the capacity of the original structure seaward of the 30-year erosion projection" (Section 161.053, Florida Statutes). The department can, however, issue a permit for landward relocation of a damaged or existing structure if the relocation will not damage the beach-dune system (Section 161.053, Florida Statutes).

#### 4.3.2.4 Coastal Building Zone

The 1985 Growth Management Act further amended the Beach and Shore Preservation Act to establish a coastal building zone extending landward of coastal construction control lines. Standards for structures within the coastal building zone are contained in the Florida Building Code. For mainland beaches, barrier spits, and peninsulas lying within Florida's sandy beach counties, the coastal building zone extends from the seasonal high water line to 1,500 feet landward of the CCCL. On barrier islands, the entire island or the area from the seasonal high water line to a maximum of 5,000 feet inland from the CCCL is included in the building zone (Section 161.54, Florida Statutes). All land areas within the Florida Keys, regardless of island size, lie within the coastal building zone.

#### 4.3.2.5 Erosion Control Program

In 1986, the Florida legislature amended the Beach and Shore Preservation Act to address the statewide problem of beach erosion through a "state-initiated program of beach restoration and beach nourishment" (Section 161.101, Florida Statutes). The legislature declared, "beach erosion is a serious menace to the economy and general welfare of the people of this state and has advanced to emergency proportions" (Section 161.088, Florida Statutes). The statute directs the FDEP to develop and maintain a comprehensive long-term management plan for restoration of Florida's critically eroding beaches (Section 161.091, Florida Statutes). The plan must provide for the following: 1) encourage the geographic coordination and sequencing of prioritized projects, 2) try to reduce equipment mobilization and demobilization costs, 3) maximize the quantity of beach-quality sand into the system, 4) extend the life of beach nourishment projects and reduce the frequency of nourishment, and 5) promote inlet sand bypassing to replicate the natural flow of sand interrupted by inlets and ports. The plan, known as the *Strategic Beach Management Plan*, is updated periodically to address changing conditions in the coastal system. Flagler County's beaches are addressed as a sub-region in the Strategic Beach Management Plan for the Northeast Atlantic Coast Region (FDEP, 2008). State funds for erosion control projects are available from Florida's Ecosystem Restoration and Management Trust Fund (Section 161.091, Florida Statutes). The fund provides money for erosion control projects consistent with the Strategic Beach Management Plan. The state can pay up to 50% of the actual non-Federal cost of restoring a critically eroding beach, while the local government in which the project occurs must provide the balance of the funds (Section 161.101, Florida Statutes). The level of state funding is directly related to the amount of public beach access and parking located within the project area.

#### 4.3.2.6 Erosion Control Line

Property rights of state and private upland owners in beach restoration project areas are set forth in Chapter 161.141, Florida Statute. The statute proclaims that the

Legislature declares that it is the public policy of the state to cause to be fixed and determined, pursuant to beach restoration, beach nourishment, and erosion control projects, the boundary line between sovereignty lands of the state bordering on the Atlantic Ocean, the Gulf of Mexico, or the Straits of Florida, and the bays, lagoons, and other tidal reaches thereof, and the upland properties adjacent thereto; except that such boundary line shall not be fixed for beach restoration projects that result from inlet or navigation channel maintenance dredging projects unless such projects involve the construction of authorized beach restoration projects. Prior to construction of such a beach restoration project, the board of trustees shall establish the line of mean high water for the area to be restored; and any additions to the upland property landward of the established line of mean high water which result from the restoration project shall remain the property of the upland owner subject to all governmental regulations and shall not be used to justify increased density or the relocation of the coastal construction control line as may be in effect for such upland property. Such resulting additions to upland property shall also be subject to a public easement for traditional uses of the sandy beach consistent with uses, which would have been allowed prior to the need for such restoration project. It is further declared that there is no intention on the part of the state to extend its claims to lands not already held by it or to deprive any upland or submerged landowner of the legitimate and constitutional use and enjoyment of his property. If an authorized beach restoration, nourishment, and erosion control project cannot reasonably be accomplished without the taking of private property, then such taking shall be made by the requesting authority by eminent domain proceedings.

#### 4.3.2.7 Local Comprehensive Planning

The Local Government Comprehensive Planning Act of 1985 (Chapter 163) requires that all local governments prepare, adopt, and implement comprehensive plans that address community growth and development needs. It requires that local, regional, and state comprehensive plans be consistent with each other and requires coastal counties and cities to include a coastal management "element" in their local plans. This section of the plan must be based on an inventory of the beach-dune system and existing coastal land uses and an analysis of the effects of future land uses on coastal resources. Local governments must also address disaster mitigation and redevelopment, designation of coastal high-hazard areas, beach protection, and shoreline use.

In response to the state's growth management mandate, Flagler County has developed a Comprehensive Plan which is premised on the County's individual unique characteristics, historical trends, current conditions and citizens' aspirations for the future of Flagler County with a desirable quality of life. Each element in Flagler County's Comprehensive Plan includes specific goals, objectives and policies that determine how the future growth of the county will be guided. The plan includes elements dealing with: Future Land Use, Transportation, Housing, Infrastructure, Coastal Management, Conservation, Recreation and Open Space,

## Intergovernmental Coordination, and Capital Improvements.

The Coastal Management Element of the Flagler County Comprehensive Plan specifies goals, objectives, and policies: 1) Preserving, protecting, or enhancing the natural and historic resources of the coastal area, 2) Reducing vulnerability to hurricanes, 3) Increasing public access to coastal resources, 4) Providing public infrastructure, and 5) Pursuing intergovernmental coordination to protect coastal resources.

The Comprehensive plan addresses post-disaster and pre-hazard mitigation. Flagler County has a comprehensive and up-to-date Hurricane Evacuation and Management Plan which is available to the public through the website [www.flagleremergency.com](http://www.flagleremergency.com).

### 4.4 Constraints

#### 4.4.1 Planning Constraints

A constraint is a restriction that limits the extent of the planning process; it is a statement of effects the alternative plans should avoid. Constraints are designed to avoid undesirable changes between the without and with-project future conditions. The planning constraints for this study area are:

- 1) Avoid conflict with Federal and state regulations, as stated in Federal law, USACE regulations, executive orders and State of Florida statutes. While local and state policy is considered for consistency, the emphasis is on legal requirements.

#### 4.4.2 Local Constraints

Local constraints are those that the sponsor wishes to avoid and will be taken into consideration. However, they are not used to screen alternatives.

- 1) Avoid impacts to current recreation caused by the implementation of a management measure, in and adjacent to the study area, during and following construction and equilibration of any potentially chosen shore protection alternative.
- 2) Preserve the unique characteristics and quality of Flagler County's beach sediments.

#### 4.5 Related Environmental Documents

This report presents the results of a feasibility-level investigation for the study area integrated with the Environmental Assessment for the recommended plan. The Appendices include the Section 404(b) Evaluation, Coastal Zone Management Consistency Determination, Pertinent Correspondence and Mailing List, Cumulative Effects Assessment, and Environmental Documentation. Section 1.6 lists pertinent previous studies. Additional environmental documents prepared in conjunction with this study are included in the references and the **Environmental Appendix F**.

#### 4.6 Decisions to be Made

The report will serve as a decision document for Federal participation related to hurricane and storm damage reduction over a 50-year period.

#### 4.7 Planning Objectives (EA Agency Objectives)

The planning objectives are statements of the study purpose. Planning objectives are more general than the Federal and non-federal objectives described in Section 4.3. Planning objectives reflect means of solving the study area's problems while taking advantage of the identified opportunities. An objective is developed to address each of the identified problems and opportunities; although a single objective may address multiple problems and opportunities simultaneously. Planning objectives represent desired positive changes in the without project future conditions.

The planning objectives for the Flagler County study area would be attained within the period of analysis for the study, a 50-year period of Federal participation. All of the objectives focus on activity within the study area.

The overarching goal of the project is to reduce the damages caused by erosion and coastal storms to shorefront structures and infrastructure within the study area. The following objectives are based on the project problems, opportunities, goals, and Federal and state objectives and regulations:

- 1) Reduce storm damages to structures and infrastructure within the Flagler County project area over the 50-year period of Federal participation.
- 2) Maintain environmental quality in the project area and adjacent areas, for human and natural use, including air and water quality, habitat, and aesthetics over the life of the project.



- 3) Maintain opportunities for recreational use of beach and nearshore areas in Flagler County including surfing, fishing, and wildlife viewing over the life of the project.
- 4) Maintain a safe hurricane evacuation route for the Flagler County project area over the life of the project.

The goal of this feasibility study is to develop a range of alternative plans that balance the objectives while avoiding conflicts or, where necessary, demonstrate the tradeoffs between conflicting objectives, enabling decisions to be made.

The Federal objective is to maximize net benefits. Because of this, it is not appropriate to identify specific targets within objectives; for example, to protect infrastructure from some effects of a pre-defined storm frequency (i.e. the 100-year storm). Rather, the planning process includes formulation and comparison of multiple alternative plans in order to recommend a plan that maximizes National Economic Development (NED) benefits relative to costs. The Federal objective to maximize net benefits supersedes any project-specific target output which does otherwise.

## 4.8 Scoping and Environmental Issues

### 4.8.1 Issues Evaluated in Detail

The following environmental issues were identified during scoping and by the preparers of this document to be relevant to any proposed action and appropriate for detailed evaluation: threatened and endangered species and essential fish habitat; preservation of the unique beach sediment characteristics, and protecting and preserving National Scenic Highway SR A1A.

### 4.8.2 Issues Eliminated from Detailed Analysis

The following issues were not considered imperative or relevant to any proposed storm damage reduction action based on scoping and the professional judgment of the preparers of this document: air quality; urban quality; solid waste; and drinking water. These items are not likely to be affected by the potential alternatives under consideration.

## 4.9 Permits, Licenses, and Entitlements \*

Water quality certification will be required prior to construction and will be obtained from the State of Florida. A Joint Coastal Permit (JCP) application for shore protection along the Flagler County HSDR project area will be prepared and submitted by USACE upon completion of the feasibility phase of the project for

purposes of obtaining water quality certification and coastal zone consistency concurrence. The physical scope and any anticipated direct or indirect impacts to coastal natural resources, along with proposed mitigation and monitoring plans of the project described in the permit application, will be equivalent to those of the selected project alternatives described herein.

# CHAPTER 5

## FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

### MEASURES EVALUATED

■ Recommended Plan

Non-Structural	Structural
No Action	Seawalls
Coastal Construction Control Line	Revetments
Moratorium on construction	Sand Covered Soft Structure
No Growth Program	Beach Nourishment
Relocation of Structures	Groins
Relocation of State Road A1A	Submerged Artificial Reef
Flood Proofing of Structures	Submerged Artificial Multi-Purpose Reef
Buyout and Land Acquisition	Nearshore Placement
	Emergent Breakwaters
	<b>Dunes and Vegetation</b>
	Pressure Equalizing Modules
	Undercurrent Stabilizers



FLAGLER COUNTY, FLORIDA  
HURRICANE AND STORM DAMAGE REDUCTION PROJECT  
FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

**CHAPTER 5**  
**FORMULATION AND EVALUATION OF ALTERNATIVE PLANS**

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\* Items required for an Environmental Assessment by the National Environmental Policy Act

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## 5 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

### 5.1 Plan Formulation Rationale \*

Plan formulation is the process of developing alternative plans which meet the project-specific objectives while avoiding constraints.

The first step of plan formulation involves identifying all potential management measures for the given problems. A management measure is a structural or nonstructural action that can be implemented at a specific geographic site to address one or more planning objectives.

An alternative plan is a set of one or more management measures functioning to address one or more objectives. Sometimes a plan consists of only one measure, but more often it's a combination of measures. Different alternative plans consist of different measures, or they combine the same measures in different ways, such as different dimensions, quantities, materials, locations or implementation time frames. As the study evolves, favorable plans are reformulated to devise the most efficient, effective, complete, and acceptable plan.

Four accounts, making up the Federal objectives, are established in the *Principles and Guidelines* (P&G 1983) to facilitate the evaluation of management measures and display the effects of alternative plans. The national economic development (NED) account displays the plan with the greatest net economic benefit consistent with protecting the nation's environment; the environmental quality (EQ) account displays non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of alternative plans; the regional economic development (RED) account displays changes in the distribution of regional economic activity (e.g., income and employment); and the other social effects (OSE) account displays plan effects on social aspects such as community impacts, health and safety, displacement, energy conservation and others. The Federal *Principles and Guidelines* require that for Hurricane and Storm Damage Reduction (HSDR) Projects the NED plan is to be the selected plan unless an exception is granted. As discussed above, the NED plan must also be evaluated in consideration of the Principles and Guidelines criteria of completeness, effectiveness, efficiency, and acceptability. Each alternative plan shall be formulated in consideration of these four criteria.

### 5.2 Management Measures

#### 5.2.1 Identification of Management Measures

Management measures were selected to accomplish at least one of the planning objectives for the Flagler County study. Both nonstructural (NS) measures and structural (S) measures were identified. All possible measures were considered, including those beyond the authority of USACE to implement. The following is a summary of the management measures to be considered for Flagler County.

---

#### NS-1: No-Action.

The no-action plan represents future conditions without the implementation of a project. Although this measure does not address any specific problems, it provides a comparison for all other measures. Information to describe this measure was collected during the inventory of existing conditions. The rate of shoreline change will be assumed to continue over the 50-year period of analysis. Present structures and replacement costs will be used into the future.

#### NS-2 : Coastal Construction Control Line.

A coastal construction control line (CCCL) that does not prohibit construction, but provides stringent structural restrictions, was established in 1988 by the State of Florida. The CCCL affects the entire coastline of Flagler County. This management measure provides for potential changes to the CCCL or building regulations that could be implemented by the State of Florida. Such changes could include moving the CCCL landward, increasing the setback for construction, or increasing the standards for construction to reduce storm damages. The erosion of the shoreline would continue at the present rate, unabated by this measure.

#### NS-3: Moratorium on Construction.

This management measure would not permit new construction in the area vulnerable to storm damages adjacent to the study area. As properties are damaged, reconstruction would not be permitted. The erosion of the shoreline would continue at the present rate, unabated by this measure. Although not a congressionally-authorized activity, this measure could be implemented by state or local governments.

#### NS-4: Establish a No-Growth Program.

This management measure would allow for limited reconstruction of existing structures following storm damage, but would not allow for an increased number of new structures within the area vulnerable to storm damages adjacent to the study area. The erosion of the shoreline would continue at the present rate, unabated by this measure. Although not a congressionally-authorized activity, this measure could be implemented by state or local governments.

#### NS-5: Relocation of Structures.

This management measure would allow the area to continue to erode and the land in this area would be lost. Structures would be identified within the study areas which are vulnerable to storm damage. Where feasible, such structures would be moved further landward on their parcels to escape the vulnerable area.

#### NS-6: Relocation of State Road A1A.

The relocation of State Road A1A (SR A1A) would allow erosion to continue along with damages to the existing SR A1A. An existing street located further inland could be designated as SR A1A or the existing SR A1A could be rerouted to a new path where it would be less susceptible to storm damages.



#### NS-7: Floodproofing of Structures.

Floodproofing existing structures and regulating flood plain and shorefront development are management measures that state and local governments could implement. This measure would require changes to the building codes to prevent flood damages associated with coastal storms. New construction and substantial reconstruction would be improved by regulation of new building codes. Existing structures could be improved through incentives and aid programs.

#### NS-8: Buyout and Land Acquisition.

This measure would allow the shoreline to erode in the study area with a loss of land. Structures within the area vulnerable to storm damage would be identified for acquisition. Structures on the acquired parcels would be demolished and natural areas restored. Such parcels would become public property and would reduce the number of structures vulnerable to storm damages.

#### S-1: Seawalls.

The construction of additional concrete seawalls or improvements to and maintenance of the existing bulkheads/seawalls would provide a significant degree of protection. The seawalls would be constructed at the seaward edge of the existing bluff or vegetation line. Existing seawalls may be demolished in favor of a new seawall to provide a seamless wall over the entire study area or sub-reaches. This measure would stabilize the shoreline at the location of the bluff, allowing erosion to continue until the seawall becomes the water line. A concrete sheet pile wall is proposed due to its stability in the salt environment and ability to withstand wave action. Construction would entail excavation into the bluff to install tie-back features. The seawall must be of sufficient depth underground to withstand projected scour by wave action and will require rock toe protection. Construction would be from the beach, with intermittent access from roads. Impacts to any nearshore resources during construction would be avoided.

#### S-2: Revetments.

Revetments have been used extensively in portions of the study area to protect critically threatened, damaged and eroding areas. This measure could include the construction of revetments or improvements to existing revetments in the study area. This measure would involve placement of large rock, designed to withstand the wave environment, along the existing bluff line. The engineered structure would start at the elevation of the bluff, tie in to existing elevations, and have a sloped profile. The structure would be embedded under the beach elevation to a depth below expected scour and future erosion. In-place materials from the excavation would be used for backfill behind the structure. Along the shoreline, the revetment should be continuous to avoid erosional features at gaps and include tie-back features at the ends. Existing armor can either be incorporated into the structure, or demolished to provide a seamless structure. Construction would be from the beach, with intermittent access from roads. Impacts to the nearshore resources during construction would be avoided.

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### S-3: Sand Covered Soft Structures.

This management measure includes construction of a dune composed of geotextile sand-filled forms (typically tubes or bags) and covered with sand. This forms a sand dune with a structured core. When storm erosion causes the structured geotextile core to become exposed the soft structure acts as armoring to prevent erosion from reaching further inland. Sand depth over the geotextile core would be maintained to an adequate depth to allow the dune to function as habitat and not inhibit sea turtle nesting.

### S-4: Beach Nourishment.

This management measure includes initial construction of a beach fill and future renourishments at periodic intervals. Renourishment of the beach would be undertaken periodically to maintain the recreational and storm damage reduction features within design dimensions. Dimensions of the beach fill would be based on the degree of protection desired or economically justified, storm damage protection of given widths of beach, and the environmental impact to the nearshore resources. Beach nourishment material (sand) would need to be available in adequate quantities. Geotechnical investigations would be conducted to identify potential offshore borrow sources. The potential for use of upland sources, as well as the beneficial use of beach quality dredged material from other sources in the region would also be investigated.

### S-5: Groins.

A series of groins in the problem area would help hold a beach in front of existing development and prevent further losses of land. The construction of groins would have to be supplemented with beach nourishment so that adjacent beaches would not be starved of sand. For this reason, groins are considered a method to help hold the fill in place and to reduce periodic nourishment requirements. The groins would be constructed of large rocks, designed to interlock together, with a foundation designed to avoid subsidence. The groins would be placed perpendicular to the shoreline and would extend from above the mean high water line out into shallow water. The length, orientation, and head of the structure (T-head or not) would be designed based on wave conditions, storms, and sediment transport. The beach fill material would come from the sources discussed in the beach nourishment structural measure, S-4. Currently groins are in use in the Marineland reach of the study area.

### S-6: Submerged Artificial Reefs.

This management measure would use the perched beach concept to limit the amount of underwater fill and retain the dry beach for a longer period. This would be accomplished by placement of a submerged artificial reef in shallow water with beach fill material placed “perched” landward of the reef structure. This measure may reduce initial fill quantities, reduce renourishment requirements and offer mitigation for the environmental impacts of potential nearshore hardbottom burial. The submerged artificial reef may be constructed using one of many various materials, and would sit on top of a foundation-type material to avoid subsidence. The beach fill material would come from the sources discussed in the beach nourishment structural measure, S-4.

### S-7: Submerged Artificial Multi-Purpose Reefs.

Submerged artificial multi-purpose reefs are designed to prevent shoreline erosion through wave energy dissipation in a way that enhances wave breaking for surfing and provides additional nearshore habitat. These submerged reefs would be located in the nearshore area outside of the footprint of typical beach fill. They could be constructed as either a stand-alone measure or in conjunction with other measures including beach nourishment.

### S-8: Nearshore Placement.

Dredged material would be placed in the nearshore to provide wave attenuation benefits, passive nourishment of the active profile, or a combination of both. This method allows placement in water depths 15 feet and deeper, avoiding direct placement covering any potential nearshore hardbottom. This management measure assumes that a portion of the sand placed in shallow water will move towards the beach under normal wave conditions. Over time following construction, the sand bar will migrate towards the beach through natural sediment transport processes, become transported onto the beach, and shaped into the natural equilibrium profile of the beach, thus adding material and enlarging the beach. The dredged material would come from the sources discussed in the beach nourishment structural measure, S-4.

### S-9: Emergent Breakwaters.

The construction of breakwaters offshore along the Flagler County study area is considered as a management measure to stabilize the beach. Such structures reduce the amount of wave energy reaching the shoreline. As a result, the rate of annual erosion would decrease. The breakwaters would be constructed of large rock with foundation materials to prevent subsidence. The breakwaters would be trapezoidal in profile and would be placed parallel to the shoreline in shallow water. The breakwater would be constructed in segments, separated from each other, to prevent infilling between the beach and the breakwater. The elevation and length of each breakwater segment and the distance between segments would be designed considering the local wave and sediment transport characteristics.

### S-10 - Dunes and Vegetation.

The presence of dunes is essential if a beach is to remain stable and able to accommodate the natural forces applied by unpredictable storms and extreme conditions of wind, wave, and elevated sea surface. Dunes maintain a sand repository that, during storms, provides sacrificial sand reserves to the eroding beach profile before upland structures would be damaged. Following large erosional events, dunes are generally replenished by natural forces provided by the calmer weather conditions following a storm. The dune system provides a measure of public safety and property protection. Proper vegetation on dunes increases sand erosion resistance by binding the sand together via extensive root masses penetrating deep into the sand. Further, such vegetation promotes dune growth through its sand trapping action when significant wind action transports substantial quantities of sand. Additionally, healthy dune systems are visually attractive to beach goers and contribute to the recreational beach experience and the all around appearance of the beach community. This measure

would include placement of beach compatible material, from either upland or offshore sources, in a dune feature adjacent to the existing bluff. The top elevation of the dune would tie into the bluff. The front slope of the dune would be a function of the material grain size and construction equipment. Vegetation would be planted after placement of the dune material.

#### S-11: Pressure Equalizing Modules (PEM)

Pressure Equalizing Modules are hollow permeable tubes inserted vertically into the beach, resulting in a well-drained beach. During falling tide, groundwater typically recedes slower than the sea, making the beach wet in the swash zone and prone to erosion. The PEM System is able to reduce water pressure in the beach which reduces erosion and prolongs the lives of nourished beaches. The PEM System works optimally where the water circulation in the swash zone is good, which favors areas with high tides and/or an active wave climate. The PEM System may be considered as a stand-alone measure or may be supplemented with beach nourishment.

#### S-12: Undercurrent Stabilizers

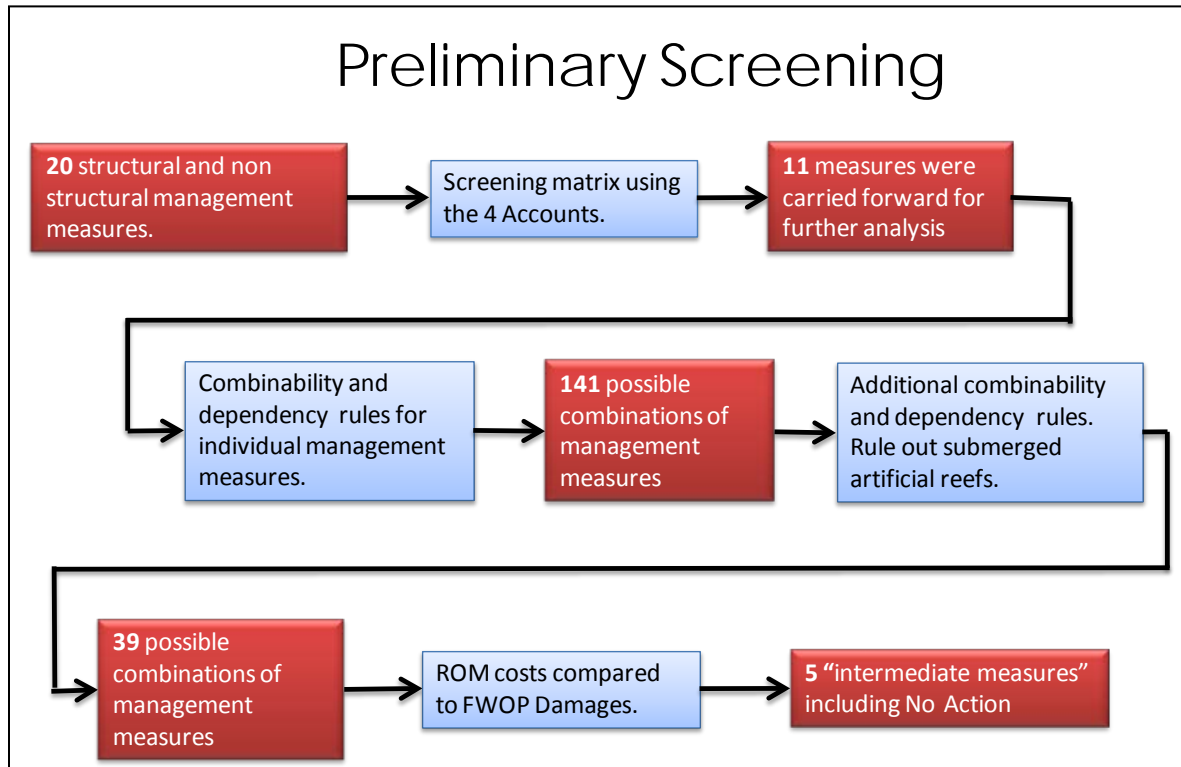
Undercurrent Stabilizers are modular geo-textile tubes filled with concrete composites, placed at right angles from the dune. The low-profile design makes the structures permeable to long shore sediment transport. The undercurrent stabilizers reduce incoming wave energy as waves approach shore, forcing suspended sand to drop out. As the stabilizers become covered with sand the beach grows in width and elevation.

### 5.3 Screening of Management Measures

The screening process was developed through several iterations of alternative development and evaluation. It was essential to screen out impractical or redundant alternatives prior to doing any detailed analysis given the number of possible alternative combinations. Screening measures was a three-step process: preliminary, intermediate, and final screening. The methodology used to screen and narrow the array of measures and alternatives to a Recommended Plan is described in the following sections.

#### 5.3.1 Preliminary Screening

**Figure 5-1** is an outline of the preliminary screening process. Descriptions of how the initial twenty structural and nonstructural management measures were screened to 5 intermediate measures (including “no-action”) is outlined in the following sub-sections.



**Figure 5-1: Preliminary Screening Flow Chart**

### 5.3.1.1 Preliminary Screening: Step 1

The array of management measures that were identified to address the planning objectives were preliminarily evaluated for their potential to contribute to the Federal objectives. During this process, the interdependency, as well as the exclusivity of measures, is identified. This process serves to eliminate some measures from further consideration. Costs and benefits are not calculated at this stage.

The Federal objectives (Four Accounts described in **Section 5.1**) were used to evaluate management measures for each of the study reaches in **Table 5-1** to **Table 5-6**. The National Economic Development (NED) account includes consideration of a measure's potential to meet the planning objective to reduce storm damages, as well as decrease costs of emergency services, lower flood insurance premiums, and consider project costs. Costs and benefits used to fully evaluate the NED objective are not calculated at this stage; however, estimates can be made to gauge the overall cost-effectiveness of a measure for this initial screening. Effects of sea-level change and a measure's adaptability to such change were considered under the National Economic Development (NED) account. The Environmental Quality (EQ) account considers ecosystem restoration, water circulation, noise level changes, public facilities and services, aesthetic values, natural resources, air and water quality, cultural and historic preservation, and other factors covered by the National Environmental Policy Act (NEPA). The EQ account is a Federal objective, but as an evaluation criterion it is inclusive of the planning objective to maintain environmental quality and reflects the

planning constraint to avoid environmental impacts to natural resources. The Other Social Effects (OSE) account includes considerations for the preservation of life, health, and public safety; community cohesion and growth; tax and property values; and, the displacement of businesses and public facilities. For evaluation purposes, the OSE account is inclusive of the planning objectives to maintain recreation and maintain a safe evacuation route, and the planning constraint to avoid conflict with legal requirements. The Regional Economic Development (RED) account considers the potential impacts on the local economy including employment, income, and sales volume.

Each measure was subjectively given a score of 0 for not meeting an objective, 1 for partially meeting an objective, and 2 for fully meeting an objective. All four objectives were given equal weight for this preliminary screening to assess how a measure stacks up across all of the Federal objectives. For later screenings, more weight will be given to the NED account since this is a project for HSDR purposes and should maximize NED benefits. With all four accounts being equal, there is a maximum of 8 points that a measure can receive which would signify that a measure has potential to fully meet the Federal objectives. A total of 4 points signifies that a measure partially meets the Federal objectives. Measures receiving a total of 3 points or less will be screened out because they do not adequately meet the Federal objectives. Measures with 4 or greater total points were carried on for further evaluation. Measures screened out were allowed to be reincorporated further along in the planning process if warranted by new developments and information.

**Table 5- 1: Marineland Non-Structural Measures**

Possible Measures		Evaluation and Effects of Possible Measures				Total Points	Carried Forward
		National Economic Development (NED)	Environmental Quality (EQ)	Other Social Effects (OSE)	Regional Economic Development (RED)		
NS-1	No-Action	No NED benefits are realized through this measure. No damages are prevented. No project costs. Makes no attempt to keep infrastructure from being damaged. No improvement.	Possible loss of dune habitat. Minimal change to other factors.	Small risk of evacuation route being damaged and a moderate risk of damages to public parking, boardwalk, and bathroom. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. Does not conflict with any laws.	Future decline in tourism as the beach and dune system erode.	1	YES, BY DEFAULT
		0	1	0	0		
NS-2	Coastal Construction Control Line	Would only provide damage reduction benefits for potential future structures. NED benefits would be minimal. Makes no attempt to keep existing infrastructure from being damaged, but the enforcement of setbacks will reduce damages to new structures in the future, especially considering potential accelerated Sea Level Rise (SLR) rates.	Enforcing setbacks will improve safety and improve the quality of the dunes. Individual private shore protection measures may affect dune habitat.	Small risk of evacuation route being damaged and a moderate risk of damages to existing public parking, boardwalk, and bathroom. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. Would require changes to state law.	Future decline in tourism as the beach and dune system erode.	2	NO
		1	1	0	0		
NS-3	Moratorium on Construction	Would only provide damage reduction benefits for potential future structures. NED benefits would likely be minimal. Makes no attempt to keep existing infrastructure from being damaged, but would reduce damages in the future, especially considering potential accelerated Sea Level Rise (SLR) rates.	Quality of the existing dune could be maintained, but still a possibility for loss of habitat from dune erosion.	Property and tax values will decrease. Will likely have an unfavorable perception. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. In the past attempts to implement a moratorium on construction have resulted in lawsuits. Changes to local laws may be needed.	Future decline in tourism as the beach and dune system erode.	2	NO
		1	1	0	0		
NS-4	Establish a No-Growth Program	Would only provide damage reduction benefits for potential future structures. NED benefits would likely be minimal. Makes no attempt to keep existing infrastructure from being damaged, but reduces potential damage in the future, especially considering potential accelerated Sea Level Rise (SLR) rates.	Quality of the existing dune could be maintained, but still a possibility for loss of habitat from dune erosion.	Property and tax values will decrease. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. May require changes to local laws.	Future decline in tourism as the beach and dune system erode.	2	NO
		1	1	0	0		
NS-5	Relocation of Structures	Benefits not likely to outweigh costs. The oceanarium is the main structure in this reach and is already protected by a seawall. Moving structure out of the way of danger will reduce damages to those structures, but as erosion continues other structures will continue to be at risk of being damaged. Additionally due to the current elevation of most infrastructure, SLR is not a significant contributing factor to storm damage over the period of analysis.	Moving buildings back from the dune would provide more area for dune habitat.	Minimal improvements to safety for parcels where this could be implemented, but overall would not have any social effects. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. Relocation of historical structures may cause conflict with section 106 of the National Historic Preservation Act.	Future decline in tourism as the beach and dune system erode.	1	NO
		0	1	0	0		
NS-6	Relocate State Highway A1A	Benefits not likely to outweigh costs as A1A is not critically threatened in this reach. This will reduce potential damages to A1A, but will not reduce damages to other infrastructure. Considering potential accelerated Sea Level Rise (SLR) rates, due to the current elevation of A1A, SLR is not a significant contributing factor to storm damage over the period of analysis.	No adverse effects would be created by this measure, nor would any positive benefits be realized.	A new hurricane evacuation route would need to be established. Moving A1A will take away from the scenic qualities of the highway. Beach berm may continue to erode leaving little or no beach for recreation. Near shore recreation will not be affected. Does not conflict with any laws. Considering potential accelerated Sea Level Rise (SLR) rates, this measure could benefit A1A's evacuation potential.	Future decline in tourism as the beach and dune system erode.	3	NO
		1	1	1	0		
NS-7	Flood Proofing of Structures	Benefits not likely to outweigh costs the oceanarium is the main structure in this reach and is already protected by a seawall. Flood proofing would reduce damages to buildings, but it would not do anything to reduce damages to other infrastructure. Additionally due to the current elevation of most infrastructure, SLR is not a significant contributing factor to storm damage over the period of analysis.	No adverse effects would be created by this measure, nor would any positive benefits be realized.	This will improve safety, but increased regulations may have an unfavorable perception. Beach berm may continue to erode leaving little or no beach for recreation. Near shore recreation will not be affected. Does not conflict with any laws.	Future decline in tourism as the beach and dune system erode.	2	NO
		0	1	1	0		
NS-8	Buyout and Land Acquisition	Benefits not likely to outweigh costs the oceanarium is the main structure in this reach and is already protected by a rock revetment. Acquired land and condemned structures will reduce the amount of infrastructure at risk of being damaged, especially considering potential accelerated Sea Level Rise (SLR) rates, but nothing is done to prevent further erosion and other damages. Additionally due to the current elevation of most infrastructure, SLR is not a significant contributing factor to storm damage over the period of analysis.	Condemning structures and acquiring land on or near the existing dune could provide more area for natural dune habitat.	Condemnation or acquisition of the oceanarium would eliminate Marineland main attraction. Acquired land could be used to create recreational areas and parks, however the beach berm may continue to erode leaving less and less recreational beach. Nearshore recreation will not be affected. Does not conflict with any laws.	Condemnation or acquisition of the oceanarium would eliminate Marineland's main attraction.	3	NO
		1	2	0	0		

  Carried Forward  
   Eliminated  
 2 Fully Meets Objective  
 1 Partially Meets Objective  
 0 Does Not Meet Objective

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**Table 5- 2: Marineland Structural Measures**

Possible Measures		Evaluation and Effects of Possible Measures				Total Points	Carried Forward
		National Economic Development (NED)	Environmental Quality (EQ)	Other Social Effects (OSE)	Regional Economic Development (RED)		
S-1	Seawalls	Benefits not likely to outweigh costs the oceanarium is the main structure in this reach and is already protected by a rock revetment. This would provide storm damage reduction to infrastructure landward of the seawall. However adjacent properties could be made more vulnerable due to erosive effects of structures. Seawalls would be moderately adaptable to potential accelerated Sea Level Rise (SLR) rates.	Likely to have negative impacts on sea turtle nesting. Not aesthetically appealing.	Could increase protection to the hurricane evacuation route and public facilities. Reflection of wave energy off the seawall will likely intensify erosion of the recreational beach berm. Near shore recreation will not be affected. Likely inconsistent with state CZMP.	Future decline in tourism as the beach erodes.	1	NO
		0	0	1	0		
S-2	Revetments	The oceanarium is currently reveted. Additional revetment is not likely to be justified in Marineland. This would provide storm damage reduction to infrastructure landward of the revetment. However adjacent properties could be made more vulnerable due to erosive effects of structures. Revetments would be adaptable to potential accelerated Sea Level Rise (SLR) rates.	Likely to have negative impacts on sea turtle nesting. Not aesthetically appealing.	Could increase protection to the hurricane evacuation route and public facilities. Reflection of wave energy off the revetment will likely intensify erosion of the recreational beach berm. Near shore recreation will not be affected. Likely inconsistent with state CZMP.	Future decline in tourism as the beach erodes.	1	NO
		0	0	1	0		
S-3	Sand Covered Soft Structure	Not likely that benefits would outweigh the costs in Marineland since the little infrastructure that is there is already protected. Would improve storm damage reduction. Would be adaptable to potential accelerated Sea Level Rise (SLR) rates.	sand would need to be maintained on top of the soft structures to ensure environmental quality. Would protect dune habitat, but could be detrimental if it became uncovered and remained that way.	could increase protection to the hurricane evacuation route and public facilities. Existing narrow beach may be maintained and nearshore recreation would not be affected. May not be permit table by the state.	Could possibly have a minor positive impact on the regional economy.	3	NO
		0	1	1	1		
S-4	Beach Nourishment	Not likely that benefits would outweigh the costs in Marineland since the little infrastructure that is there is already protected. This would reduce damages to infrastructure landward of the nourishment. Would be highly adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could result in temporary negative impacts to the nearshore environment during construction. Nearshore rock outcroppings would need to be avoided. Could enhance sea turtle nesting habitat.	could increase protection to the hurricane evacuation route and public facilities. The recreational beach berm would be extended. Nearshore recreation such as surfing and fishing may be affected temporarily following nourishments. Does not conflict with any laws.	Could possibly have a minor positive impact on the regional economy.	3	NO
		0	1	1	1		
S-5	Groins	Several older groins, damaged but appear to be semi-functional exist in Marineland. Additional groins are not likely to be justified in Marineland. In combination with beach nourishment, groins could be used at hot spots to stabilize fill and maximize storm damage reduction. Would be moderately adaptable to potential accelerated Sea Level Rise (SLR) rates.	Periodic renourishments could be reduced by stabilizing the beach. Possible entrapment hazard for hatching sea turtles.	Because only select areas would benefit, groins would not likely receive support from the entire community. In select areas the recreational beach berm would be extended. Nearshore recreation such as surfing and fishing may be affected following nourishments. New groins may not be permit table by the state. Prohibited by County Comp Plan.	Could possibly have a minor positive impact on the regional economy.	2	NO
		0	1	0	1		
S-6	Submerged Artificial Reefs	Not likely to be justified in Marinelands, in combination with beach nourishment, and shore perpendicular structure, could maximize storm damage reduction. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could enhance nearshore fish habitat. Same considerations associated with beach fill. Could have temporary negative impact during construction.	May create a safety hazard for swimmers. Would provide protection for the evacuation route. The recreational beach berm would be maintained. Nearshore recreation such as surfing and fishing may be positively or negatively affected. May not be permit table by the state.	Could possibly have a minor positive impact on the regional economy.	3	NO
		0	1	1	1		
S-7	Submerged Artificial Multi-Purpose Reefs	Not likely that this measure would be justified in Marineland. Could provide storm damage reduction, in combination with beach fill, for infrastructure seaward of the reef. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could have temporary negative impact during construction, but would likely improve sea turtle nesting habitat by maintaining a beach berm and create habitat for nearshore marine life.	May create a safety hazard for swimmers. Would provide protection for the evacuation route. The recreational beach berm would be maintained. Nearshore recreation such as surfing and fishing should improve if correctly designed/constructed. May not be permit table by the state.	Could possibly have a minor positive impact on the regional economy.	3	NO
		0	1	1	1		
S-8	Nearshore Placement	Not likely to be justified in Marineland. Some reduction to infrastructure could be realized depending on the migration of the placed sand.	May have temporary impacts to the nearshore environment during and following construction. Depending on sand migration, volume of sand needed to provide significant benefits could have a negative impact to sea turtle nesting habitat dependent on migration of fill. However, sand could also have a positive, or no, impact on turtles depending on migration.	Depending on how the sand migrates, this could be viewed negatively by the community. Added protection would likely be minimal in this reach. Nearshore recreation may be positively or negatively affected following placement. Beach recreation would be maintained. May not be permit table by the state.	Could possibly have a minor positive impact on the regional economy.	2	NO
		0	1	0	1		
S-9	Emergent Breakwaters	Not likely to be justified in Marineland. Could provide storm damage reduction, in combination with beach fill, for infrastructure landward of the breakwaters. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could affect the nearshore environment during construction. May block turtle nesting lanes. Could possibly create nearshore habitat. May have a negative effect on adjacent shorelines.	May not be aesthetically pleasing. Could be a navigational hazard for boaters and may pose a safety risk for swimmers. Nearshore recreation may be positively or negatively affected. Beach recreation would be maintained. May not be permit table by the state.	Could possibly have a minor positive impact on the regional economy.	2	NO
		0	1	0	1		
S-10	Dunes and Vegetation	Not likely to be justified in Marineland. Could provide a certain level of protection as a stand alone measure or in combination with other measures. Could provide a certain level of protection as a stand alone measure. Would be adaptable to potential accelerated Sea Level Rise (SLR) rates.	Dune habitat would be enhanced and expanded. Not likely to have any negative impacts. Aesthetically appealing. Existing Vegetation and beach rock outcrops may be impacted.	Likely to be supported by a majority of the community. This would likely maintain dunes but nearshore recreation could decline. Nearshore recreation would not be affected. Does not conflict with any laws. A locally constructed dune rehabilitation project was done successfully in the past.	Could possibly have a minor positive impact on the regional economy.	3	NO
		0	1	1	1		
S-11	Pressure Equalizing Modules (PEMs)	Not likely that this measure would be justified in Marineland. PEMs may provide storm damage reduction to infrastructure. Not likely that they would work as a stand alone measure. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Not likely to have any significant environmental effects other than those associated with beach fill.	Could have positive social impacts if they work in enhancing the beach. Beach recreation would be maintained and possibly enhanced. Nearshore recreation would most likely not be affected. Does not conflict with any laws.	Could possibly have a minor positive impact on the regional economy.	3	NO
		0	1	1	1		
S-12	Undercurrent Stabilizers	Not likely to be justified in Marineland. Could hold sand in place reducing damages for a specific area. May trap sand that would otherwise feed another area of the project depriving it of damage reduction benefits. Would be moderately adaptable to potential accelerated Sea Level Rise (SLR) rates.	Possible entrapment hazard for hatching sea turtles. Not proposed for use in conjunction with beach nourishment, therefore could have negative impacts on adjacent shorelines.	Because only select areas would benefit, undercurrent stabilizers may not receive support from the entire community. Would add some protection to the evacuation route. In select areas the recreational beach berm may be maintained or possibly extended. Nearshore recreation such as surfing and fishing may be positively or negatively affected. May not be permit table by the state. Prohibited by County Comp Plan.	Could possibly have a minor positive impact on the regional economy.	2	NO
		0	0	1	1		

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   Eliminated  
 2 Fully Meets Objective  
 1 Partially Meets Objective  
 0 Does Not Meet Objective

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**Table 5- 3: Painters Hill and Beverly Beach Non-Structural Measures**

Possible Measures	Evaluation and Effects of Possible Measures				Total Points	Carried Forward
	National Economic Development (NED)	Environmental Quality (EQ)	Other Social Effects (OSE)	Regional Economic Development (RED)		
NS-1 No-Action	No NED benefits are realized through this measure. No damages are prevented. No project costs. Makes no attempt to keep infrastructure from being damaged. No improvement.	Potential for continued dune and dune habitat loss. Minimal change to other factors. Individual private shore protection measures may affect dune habitat.	Small risk of damage to evacuation route. Moderate risk to oceanfront homes and the safety of homeowners. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. Does not conflict with any laws.	Potential for loss of property value and tax value.	1	YES, BY DEFAULT
	0	1	0	0		
NS-2 Coastal Construction Control Line	Would only provide damage reduction benefits for potential future structures. NED benefits would be minimal. Costs would be minimal. The enforcement of setbacks will reduce damages to new structures in the future, especially considering potential accelerated Sea Level Rise (SLR) rates.	Enforcing setbacks will improve safety and improve the quality of the dunes. Individual private shore protection measures may affect dune habitat.	Ocean front property owners may not like this. Small risk of damage to evacuation route. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. Would require changes to state law.	Potential for loss of property value and tax value.	2	NO
	1	1	0	0		
NS-3 Moratorium on Construction	Would only provide damage reduction benefits for potential future structures. NED benefits would be minimal. Makes no attempt to keep existing infrastructure from being damaged, but would reduce damages in the future, especially considering potential accelerated Sea Level Rise (SLR) rates.	Potential for continued dune and dune habitat loss. Minimal change to other factors. Individual private shore protection measures may affect dune habitat.	Property and tax values will decrease. Will likely have an unfavorable perception. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. In the past attempts to implement a moratorium on construction have resulted in lawsuits. Changes to local laws would be needed.	Potential for loss of property value and tax value.	2	NO
	1	1	0	0		
NS-4 Establish a No-Growth Program	Would only provide damage reduction benefits for potential future structures. NED benefits would be minimal. Makes no attempt to keep existing infrastructure from being damaged, but reduces potential damage in the future, especially considering potential accelerated Sea Level Rise (SLR) rates.	No adverse effects would be created by this measure, nor would any positive benefits be realized.	Property and tax values will decrease. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. May require changes to local law.	Potential for loss of property value and tax value.	1	NO
	1	0	0	0		
NS-5 Relocation of Structures	Benefits not likely to outweigh costs in this study reach. Moving structure out of the way of danger will reduce damages to those structures, but as erosion continues other structures will continue to be at risk of being damaged. Additionally due to the current elevation of most infrastructure, SLR is not a significant contributing factor to storm damage over the period of analysis.	Moving buildings back from the dune would provide more area for dune habitat. Dune would still face potential threat of continued erosion.	Minimal improvements to safety for parcels where this could be implemented, but overall would not have any social effects. Beach berm may continue to erode leaving little or no beach for recreation. Near shore recreation will not be affected. Does not conflict with any laws.	Potential for loss of property value and tax value.	1	NO
	0	1	0	0		
NS-6 Relocate State Highway A1A	Benefits not likely to outweigh costs as A1A is not critically threatened in this reach. This will reduce damages to A1A, but will not reduce damages to other infrastructure. Considering potential accelerated Sea Level Rise (SLR) rates, due to the current elevation of A1A, SLR is not a significant contributing factor to storm damage over the period of analysis.	No adverse effects would be created by this measure, nor would any positive benefits be realized.	A new hurricane evacuation route would need to be established. Moving A1A will take away from the scenic qualities of the highway. Beach berm may continue to erode leaving little or no beach for recreation. Near shore recreation will not be affected. Does not conflict with any laws.	Businesses along A1A will suffer if the highway is relocated. Potential for loss of property value and tax value.	2	NO
	1	1	0	0		
NS-7 Flood Proofing of Structures	Damage reduction benefits for structures would be realized, but other infrastructure would not see any benefits. Flood proofing would reduce damages to buildings, but it would not do anything to reduce damages to other infrastructure. Considering Sea Level Rise, due to the current elevation of most infrastructure, SLR is not a significant contributing factor to storm damage over the period of analysis.	No adverse effects would be created by this measure, nor would any positive benefits be realized.	This will improve safety, but increased regulations may have an unfavorable perception. Small risk to evacuation route remains. Beach berm may continue to erode leaving little or no beach for recreation. Near shore recreation will not be affected. May require changes to state law.	Potential for loss of property value and tax value.	2	NO
	1	1	0	0		
NS-8 Buyout and Land Acquisition	Benefits could possibly outweigh the costs. Condemnation of structures and conversion of land to a natural area will eliminate damages to infrastructure. Erosion could continue to threaten landward infrastructure in the future. Additionally due to the current elevation of most infrastructure, SLR is not a significant contributing factor to storm damage over the period of analysis.	Condemnation of structures and their removal would provide more area for dune habitat. Dune would still face potential threat of continued erosion.	Acquired land could be used in ways that could be beneficial to the overall community. Shorefront property owners would not like this. Small risk to evacuation route remains. Acquired land could be used to create recreational areas and parks, however the beach berm may continue to erode leaving less and less recreational beach. Nearshore recreation will not be affected. Does not conflict with any laws.	Acquired land used for public parks could contribute to regional recreational and tourism economic benefits.	4	YES
	1	1	1	1		

  Carried Forward
   Eliminated
 2 Fully Meets
 1 Partially Meets
 0 Does Not Meet

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**Table 5- 4: Painters Hill and Beverly Beach Structural Measures**

Possible Measures		Evaluation and Effects of Possible Measures				Total Points	Carried Forward
		National Economic Development (NED)	Environmental Quality (EQ)	Other Social Effects (OSE)	Regional Economic Development (RED)		
S-1	Seawalls	Could possibly be justified. This would provide storm damage reduction to infrastructure landward of the seawall. However adjacent properties could be made more vulnerable due to erosive effects of structures. Damage reduction could be maximized in combination with beach/dune fill to offset impacts to adjacent shoreline. Seawalls would be moderately adaptable to potential accelerated Sea Level Rise (SLR) rates.	Much of these study reaches have no seawalls except for at the Camptown RV Park and nd 2 private vinyl seawalls. Likely to have negative impacts on sea turtle nesting. Not aesthetically appealing.	Maybe supported by homeowners. May face objection by community. Could have negative effect on surrounding beaches. Reflection of wave energy off the seawall will likely intensify erosion of the recreational beach berm. Near shore recreation will not be affected. Likely inconsistent with state CZMP.	Could possibly have a minor positive impact on the regional economy.		YES
		2	0	1	1	4	
S-2	Revetments	Could possibly be justified. This would provide storm damage reduction to infrastructure landward of the revetment. However adjacent properties could be made more vulnerable due to erosive effects of structures. Damage reduction could be maximized in combination with beach/dune fill to offset impacts to adjacent shoreline. Revetments would be adaptable to potential accelerated Sea Level Rise (SLR) rates.	None of these study reaches currently have revetments. Likely to have negative impacts on sea turtle nesting. Not aesthetically appealing.	Maybe supported by homeowners. May face objection by community. Could have negative effect on surrounding beaches. Reflection of wave energy off the revetment will likely intensify erosion of the recreational beach berm. Near shore recreation will not be affected.	Could possibly have a minor positive impact on the regional economy.		YES
		2	0	1	1	4	
S-3	Sand Covered Soft Structure	Could possibly be justified. would improve storm damage reduction. Would be adaptable to potential accelerated Sea Level Rise (SLR) rates.	sand would need to be maintained on top of the soft structures to ensure environmental quality. Would protect dune habitat, but could be detrimental if it became uncovered and remained that way.	would protect evacuation route, shorefront property, and residents. existing narrow beach may be maintained and nearshore recreation would not be affected. May not be permissible by the state.	Could possibly have a minor positive impact on the regional economy.		YES
		1	1	2	1	5	
S-4	Beach Nourishment	Most likely a justifiable measure. This would reduce damages to infrastructure landward of the nourishment. Would be highly adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could result in temporary negative impacts to the nearshore environment. Could enhance sea turtle nesting habitat. Would need to avoid nearshore rock if present. If sand color is changed the beach may lose aesthetic quality.	Likely to be supported by homeowners and a majority of the community. Public parking and access would need to be increased in this reach for Fed. Participation. Improved protection of the evacuation route. The recreational beach berm would be extended. Nearshore recreation such as surfing and fishing may be affected temporarily following nourishments. Does not conflict with any laws.	Could possibly have a minor positive impact on the regional economy.		YES
		2	1	2	1	6	
S-5	Groins	Could possibly be justified. In combination with beach nourishment, groins could be used at hot spots to stabilize fill and maximize storm damage reduction. Would be moderately adaptable to potential accelerated Sea Level Rise (SLR) rates.	Periodic renourishments could be reduced by stabilizing the beach. Possible entrapment hazard for hatchling sea turtles.	Because only select areas would benefit, groins may not receive support from the entire community. Would add some protection to the evacuation route. In select areas the recreational beach berm would be extended. Nearshore recreation such as surfing and fishing may be affected following nourishments. May not be permissible by the state. Prohibited by Counties Comp Plan.	Could possibly have a minor positive impact on the regional economy.		YES
		1	1	1	1	4	
S-6	Submerged Artificial Reefs	Could have temporary negative impact during construction, but would likely improve sea turtle nesting habitat by maintaining a beach berm and create habitat for nearshore marine life. Constructed in select locations, in combination with beach nourishment, and shore perpendicular structure, could maximize storm damage reduction. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could enhance nearshore fish habitat. Same considerations associated with beach fill.	May create a safety hazard for swimmers. Would provide protection for the evacuation route. The recreational beach berm would be maintained. Nearshore recreation such as surfing and fishing may be positively or negatively affected. May not be permissible by the state.	Could possibly have a minor positive impact on the regional economy.		YES
		1	1	1	1	4	
S-7	Submerged Artificial Multi-Purpose Reefs	Could possibly be justified. Could provide storm damage reduction, in combination with beach fill, for infrastructure landward of the reef. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could have temporary negative impact during construction, but would likely improve sea turtle nesting habitat by maintaining a beach berm and create habitat for nearshore marine life.	May create a safety hazard for swimmers. Would provide protection for the evacuation route. The recreational beach berm would be maintained. Nearshore recreation such as surfing and fishing should improve if correctly designed/constructed. May not be permissible by the state.	Likely to have a positive effect on local tourism industry.		YES
		1	1	1	2	5	
S-8	Nearshore Placement	Could possibly be justified. Some reduction to infrastructure could be realized depending on the migration of the placed sand. Would be highly adaptable to potential accelerated Sea Level Rise (SLR) rates.	May have temporary impacts to the nearshore environment during and following construction. Depending on sand migration, volume of sand needed to provide significant benefits could have a negative impact to sea turtle nesting habitat dependent on migration of fill. However, sand could also have a positive, or no, impact on turtles depending on migration.	Depending on how the sand migrates, this could be viewed negatively by the community. Nearshore recreation may be affected following placement. Beach recreation would be maintained. May not be permissible by the state.	Could possibly have a minor positive impact on the regional economy.		NO
		1	1	0	1	3	
S-9	Emergent Breakwaters	Could possibly be justified. Could provide storm damage reduction, in combination with beach fill, for infrastructure landward of the breakwaters. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could affect the nearshore environment during construction. May block turtle nesting lanes. Could possibly create nearshore habitat. May have a negative effect on adjacent shorelines.	May not be aesthetically pleasing. Could be a navigational hazard for boaters and may pose a safety risk for swimmers. Nearshore recreation may be positively or negatively affected. Beach recreation would be maintained. May not be permissible by the state.	Could possibly have a minor positive impact on the regional economy.		NO
		1	1	0	1	3	
S-10	Dunes and Vegetation	Could possibly be justified. Could provide a certain level of protection as a stand alone measure or in combination with other measures. Could provide a certain level of protection as a stand alone measure. Would be adaptable to potential accelerated Sea Level Rise (SLR) rates.	Dune habitat would be enhanced and expanded. Not likely to have any negative impacts. Aesthetically appealing.	Likely to be supported by a majority of the community. Would moderately increase protection of the evacuation route. This would likely maintain dunes but nearshore recreation could decline. Nearshore recreation would not be affected. Does not conflict with any laws.	Could possibly have a minor positive impact on the regional economy.		YES
		1	2	1	1	5	
S-11	Pressure Equalizing Modules (PEMs)	Not likely to be justified. Has not been shown to work in a coastal environment similar to Flagler County. Not likely that they would work as a stand alone measure. PEMs may provide storm damage reduction to infrastructure in combination with nourishment, but additional benefits would not likely be justified. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Not likely to have any significant environmental effects other than those associated with a combined beach fill.	Could have positive social impacts if they work in enhancing the beach. Beach recreation would be maintained and possibly enhanced. Nearshore recreation would most likely not be affected. Does not conflict with any laws.	Could possibly have a minor positive impact on the regional economy.		NO
		0	1	1	1	3	
S-12	Undercurrent Stabilizers	Not likely to be justified. Has not been shown to work in a coastal environment similar to Flagler County. Could hold sand in place reducing damages for a specific area. May trap sand that would otherwise feed another area of the project depriving it of damage reduction benefits. Would be moderately adaptable to potential accelerated Sea Level Rise (SLR) rates.	Possible entrapment hazard for hatchling sea turtles. Not proposed for use in conjunction with beach nourishment, therefore could have negative impacts on adjacent shorelines.	Because only select areas would benefit, undercurrent stabilizers may not receive support from the entire community. Would add some protection to the evacuation route. In select areas the recreational beach berm may be maintained or possibly extended. Nearshore recreation such as surfing and fishing may be positively or negatively affected. May not be permissible by the state. Prohibited by Counties Comp Plan.	Could possibly have a minor positive impact on the regional economy.		NO
		0	0	1	1	2	

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**Table 5- 5: Flagler Beach Non-Structural Measures**

Possible Measures	Evaluation and Effects of Possible Measures				Total Points	Carried Forward
	National Economic Development (NED)	Environmental Quality (EQ)	Other Social Effects (OSE)	Regional Economic Development (RED)		
NS-1 No-Action	No NED benefits are realized through this measure. No damages are prevented. No project costs. Makes no attempt to keep infrastructure from being damaged. No improvement. 0	Potential for continued loss of the already minimal dune and dune habitat. Minimal change to other factors. Individual private shore protection measures may affect dune habitat. 1	Moderate risk of damage to evacuation route. Small risk to homes, businesses and the safety of residents. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. Does not conflict with any laws. 1	Potential for loss of property value and tax value. Potential for decline in local business revenues. 0	2	YES, BY DEFAULT
NS-2 Coastal Construction Control Line	Would only provide damage reduction benefits for potential future structures. NED benefits would be minimal. Costs would be minimal. The enforcement of setbacks will reduce damages to new structures in the future, especially considering potential accelerated Sea Level Rise (SLR) rates. 1	Enforcing setbacks will improve safety and improve the quality of the dunes. Individual private shore protection measures may affect dune habitat. 1	Will likely have an unfavorable perception by home owners. Moderate risk of damage to evacuation route. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. Would require changes to state law. 0	Potential for loss of property value and tax value. 0	2	NO
NS-3 Moratorium on Construction	Would only provide damage reduction benefits for potential future structures. NED benefits would be minimal. Makes no attempt to keep existing infrastructure from being damaged, but would reduce damages in the future, especially considering potential accelerated Sea Level Rise (SLR) rates. 1	Potential for continued dune and dune habitat loss. Minimal change to other factors. Individual private shore protection measures may affect dune habitat. 1	Property and tax values will decrease. Will likely have an unfavorable perception. Risk of damage to the evacuation route remains. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. In the past attempts to implement a moratorium on construction have resulted in lawsuits. Changes to local laws would be needed. 0	Potential for loss of property value and tax value. 0	2	NO
NS-4 Establish a No-Growth Program	Would only provide damage reduction benefits for potential future structures. NED benefits would be minimal as there is little room for growth east of A1A. Makes no attempt to keep existing infrastructure from being damaged, but reduces potential damage in the future, especially considering potential accelerated Sea Level Rise (SLR) rates. 1	No adverse effects would be created by this measure, nor would any positive benefits be realized. 0	Property and tax values will decrease. Risk of damage to the evacuation route remains. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. May require changes to local law. 0	Potential for loss of property value and tax value. 0	1	NO
NS-5 Relocation of Structures	Benefits not likely to outweigh costs in this study reach. Moving structure out of the way of danger will reduce damages to those structures, but as erosion continues other structures will continue to be at risk of being damaged. Additionally due to the current elevation of most infrastructure, SLR is not a significant contributing factor to storm damage over the period of analysis. 0	Moving buildings back from the dune would provide more area for dune habitat. Dune would still face potential threat of continued erosion. 1	Minimal improvements to safety for parcels where this could be implemented, but overall would not have any social effects. Risk of damage to the evacuation route remains. Beach berm may continue to erode leaving little or no beach for recreation. Near shore recreation will not be affected. Relocation of historical structures may cause conflict with section 106 of the National Historic Preservation Act 0	Potential for loss of property value and tax value. 0	1	NO
NS-6 Relocate State Highway A1A	Measure may be justified as damages to the highway would be avoided. This will reduce damages to A1A, but will not reduce damages to other infrastructure. Considering potential accelerated Sea Level Rise (SLR) rates, due to the current elevation of A1A, SLR is not a significant contributing factor to storm damage over the period of analysis. 1	Moving A1A inland may create more area for dune habitat. Dune would still face potential threat of continued erosion. 1	A new hurricane evacuation route would need to be established. Moving A1A will take away from the scenic qualities of the highway. Likely to be opposed by much of the community. Beach berm may continue to erode leaving little or no beach for recreation. Near shore recreation will not be affected. Does not conflict with any laws. 0	Businesses along A1A will suffer if the highway is relocated. Potential for loss of property value and tax value. 0	2	NO
NS-7 Flood Proofing of Structures	Damage reduction benefits for structures would be realized, but other infrastructure would not see any benefits. Flood proofing would reduce damages to buildings, but it would not do anything to reduce damages to other infrastructure. Considering Sea Level Rise, due to the current elevation of most infrastructure, SLR is not a significant contributing factor to storm damage over the period of analysis. 1	No adverse effects would be created by this measure, nor would any positive benefits be realized. 1	This will improve safety, but increased regulations may have an unfavorable perception. Risk to evacuation route remains. Beach berm may continue to erode leaving little or no beach for recreation. Near shore recreation will not be affected. May require changes to state law. 0	Potential for loss of property value and tax value. 0	2	NO
NS-8 Buyout and Land Acquisition	Benefits not likely to outweigh costs. Condemnation of structures and conversion of land to a natural area will eliminate damages to infrastructure. However this measure will not protect A1A which is the most seaward damage element in this study reach. Additionally due to the current elevation of most infrastructure, SLR is not a significant contributing factor to storm damage over the period of analysis. 0	Condemnation of structures and their removal would provide more area for dune habitat. Dune would still face potential threat of continued erosion. 1	Acquired land could be used in ways that could be beneficial to the overall community. Property owners would not like this. Risk to evacuation route remains. Acquired land could be used to create recreational areas and parks, however the beach berm may continue to erode leaving less and less recreational beach. Nearshore recreation will not be affected. Does not conflict with any laws. 0	Acquired land used for public parks could contribute to regional recreational and tourism economic benefits. 1	2	NO

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  Partially Meets
  Does Not Meet

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**Table 5- 6: Flagler Beach Structural Measures**

Possible Measures		Evaluation and Effects of Possible Measures				Total Points	Carried Forward
		National Economic Development (NED)	Environmental Quality (EQ)	Other Social Effects (OSE)	Regional Economic Development (RED)		
S-1	Seawalls	Could be justified in certain areas, but not likely to be justified over the entire project area. This would provide storm damage reduction to infrastructure landward of the seawall. However adjacent properties could be made more vulnerable due to erosive effects of structures. Damage reduction could be maximized in combination with beach/dune fill to offset impacts to adjacent shoreline. Seawalls would be moderately adaptable to potential accelerated Sea Level Rise (SLR) rates.	As seawall currently exist in this study reach, the environmental w/o project conditions would not be significantly altered should a new seawall be built in the location of an existing seawall. New seawall built where no seawall exists would likely have negative environmental impacts.	Likely to face objection by community and resource agencies. Could have negative effect on surrounding beaches. Reflection of wave energy off the seawall will likely intensify erosion of the recreational beach berm. Near shore recreation will not be affected. Likely inconsistent with state CZMP.	As seawall currently exist in this study reach, the regional economic w/o project conditions would not be significantly altered should a new seawall be built in the location of an existing seawall. New seawall built where no seawall exists could likely cause increased erosion of the berm which may negatively affect local tourism.		YES
		2	1	1	1	5	
S-2	Revetments	Portions of this study reach are currently reveted. Could be justified in certain areas, but not likely to be justified over the entire area of the project. This would provide storm damage reduction to infrastructure landward of the revetment. However adjacent properties could be made more vulnerable due to erosive effects of structures. Damage reduction could be maximized in combination with beach/dune fill to offset impacts to adjacent shoreline. Revetments would be adaptable to potential accelerated Sea Level Rise (SLR) rates.	As revetment currently exist in much of this study reach, the environmental w/o project conditions would not be significantly altered should a new revetment be built in the location of an existing revetment. New revetment built where no revetment exists would likely have negative environmental impacts.	Likely to face objection by community. Could have negative effect on surrounding beaches. Reflection of wave energy off the revetment will likely intensify erosion of the recreational beach berm. Near shore recreation will not be affected. Likely inconsistent with state CZMP.	As revetment currently exist in this study reach, the regional economic w/o project conditions would not be significantly altered should a new revetment be built in the location of an existing revetment. New revetment built where no revetment exists could likely cause increased erosion of the berm which may negatively affect local tourism.		YES
		2	1	1	1	5	
S-3	Sand Covered Soft Structure	Could possibly be justified. would improve storm damage reduction. Would be adaptable to potential accelerated Sea Level Rise (SLR) rates.	sand would need to be maintained on top of the soft structures to ensure environmental quality. Would protect dune habitat, but could be detrimental if it became uncovered and remained that way.	would protect evacuation route and improve the aesthetics along ATA compared to the existing revetment. existing narrow beach may be maintained and nearshore recreation would not be affected. May not be permissible by the state.	Could possibly have a minor positive impact on the regional economy.		YES
		1	1	2	1	5	
S-4	Beach Nourishment	Most likely a justifiable measure. This would reduce damages to infrastructure landward of the nourishment. Would be highly adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could result in temporary negative impacts to the nearshore environment. Could enhance sea turtle nesting habitat. Would need to avoid nearshore rock if present. If sand color is changed the beach may lose aesthetic quality.	Likely to be supported by a majority of the community. Improved protection of the evacuation route. The recreational beach berm would be extended. Nearshore recreation such as surfing and fishing may be affected temporarily following nourishments. Does not conflict with any laws.	Likely to have a positive effect on local tourism industry.		YES
		2	1	2	2	7	
S-5	Groins	Could possibly be justified and reduce periodic nourishment in select areas, however would not likely be feasible over the entire project area. In combination with beach nourishment, groins could be used at hot spots to stabilize fill and maximize storm damage reduction. Would be moderately adaptable to potential accelerated Sea Level Rise (SLR) rates.	Periodic renourishments could be reduced by stabilizing the beach. Possible entrapment hazard for hatchling sea turtles. Not aesthetically appealing.	Because only select areas would benefit, groins may not receive support from the entire community. Would add some protection to the evacuation route. In select areas the recreational beach berm would be extended. Nearshore recreation such as surfing and fishing may be affected following nourishments. May not be permissible by the state. Prohibited by Counties Comp Plan.	Could possibly have a minor positive impact on the regional economy.		YES
		1	1	1	1	4	
S-6	Submerged Artificial Reefs	Could possibly be justified. Constructed in select locations, in combination with beach nourishment, and shore perpendicular structure, could maximize storm damage reduction. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could enhance nearshore fish habitat. Same considerations associated with beach fill.	May create a safety hazard for swimmers. Would provide protection for the evacuation route. The recreational beach berm would be maintained. Nearshore recreation such as surfing and fishing may be positively or negatively affected. May not be permissible by the state.	Could possibly have a minor positive impact on the regional economy.		YES
		1	1	1	1	4	
S-7	Submerged Artificial Multi-Purpose Reefs	Could possibly be justified in areas of this study reach. Could provide storm damage reduction, in combination with beach fill, for infrastructure landward of the reef.	Could have temporary negative impact during construction, but would likely improve sea turtle nesting habitat by maintaining a beach berm and create habitat for nearshore marine life.	May create a safety hazard for swimmers. Would provide protection for the evacuation route. The recreational beach berm would be maintained. Nearshore recreation such as surfing and fishing should improve if correctly designed/constructed. May not be permissible by the state.	Likely to have a positive effect on local tourism industry.		YES
		1	1	1	2	5	
S-8	Nearshore Placement	Could possibly be justified. Some reduction to infrastructure could be realized depending on the migration of the placed sand. Would be highly adaptable to potential accelerated Sea Level Rise (SLR) rates.	May have temporary impacts to the nearshore environment during and following construction. Depending on sand migration, volume of sand needed to provide significant benefits could have a negative impact to sea turtle nesting habitat dependent on migration of fill. However, sand could also have a positive, or no,	Depending on how the sand migrates, this could be viewed negatively by the community. Improved protection of the evacuation route may be minimal. Nearshore recreation may be affected following placement. Beach recreation would be maintained. May not be permissible by the state.	Could possibly have a minor positive impact on the regional economy.		NO
		1	1	0	1	3	
S-9	Emergent Breakwaters	Could possibly be justified. Could provide storm damage reduction, in combination with beach fill, for infrastructure landward of the breakwaters. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Could affect the nearshore environment during construction. May block turtle nesting lanes. Could possibly create nearshore habitat. May have a negative effect on adjacent shorelines.	May not be aesthetically pleasing. Could be a navigational hazard for boaters and may pose a safety risk for swimmers. Nearshore recreation may be positively or negatively affected. Beach recreation could be maintained. May not be permissible by the state.	Could possibly have a minor positive impact on the regional economy.		NO
		1	1	0	1	3	
S-10	Dunes and Vegetation	Could possibly be justified. Could provide a certain level of protection as a stand alone measure or in combination with other measures. Would be adaptable to potential accelerated Sea Level Rise (SLR) rates.	Dune habitat would be enhanced and expanded. Not likely to have any negative impacts. Aesthetically appealing.	Likely to be supported by a majority of the community. Would moderately increase protection of the evacuation route. This would likely maintain dunes but nearshore recreation could decline. Nearshore recreation would not be affected. Does not conflict with any laws.	Could possibly have a minor positive impact on the regional economy.		YES
		1	2	1	1	5	
S-11	Pressure Equalizing Modules (PEMs)	Not likely to be justified. Has not been shown to work in a coastal environment similar to Flagler County. Not likely that they would work as a stand alone measure. PEMs may provide storm damage reduction to infrastructure in combination with nourishment, but additional benefits would not likely be justified. Would be minimally adaptable to potential accelerated Sea Level Rise (SLR) rates.	Not likely to have any significant environmental effects other than those associated with a combined beach fill.	Could have positive social impacts if they work in enhancing the beach. May add some protection to the evacuation route. Beach recreation would possibly be maintained or enhanced. Nearshore recreation would most likely not be affected. Does not conflict with any laws.	Could possibly have a minor positive impact on the regional economy.		NO
		0	1	1	1	3	
S-12	Undercurrent Stabilizers	Not likely to be justified. Has not been shown to work in a coastal environment similar to Flagler County. Could hold sand in place reducing damages for a specific area. May trap sand that would otherwise feed another area of the project depriving it of damage reduction benefits. Would be moderately adaptable to potential accelerated Sea Level Rise (SLR) rates.	Possible entrapment hazard for hatchling sea turtles. Not proposed for use in conjunction with beach nourishment, therefore could have negative impacts on adjacent shorelines.	Because only select areas would benefit, undercurrent stabilizers may not receive support from the entire community. Would add some protection to the evacuation route. In select areas the recreational beach berm may be maintained or possibly extended. Nearshore recreation such as surfing and fishing may be positively or negatively affected. May not be permissible by the state. Prohibited by Counties Comp Plan.	Could possibly have a minor positive impact on the regional economy.		NO
		0	0	1	1	2	

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**Table 5- 1** to **Table 5- 6** present a preliminary evaluation of the possible management measures considered in the first step of plan formulation compared to the Federal objectives represented by the four accounts. Many of the measures did not fully address the screening criteria and were not carried forward to the next phase of analysis. Management measures with the greatest potential to contribute to planning objectives, Federal objectives, and consistency with planning constraints were carried forward for each study reach. The no-action measure was carried forward as an alternative plan throughout plan formulation as required by NEPA and as a basis for comparison with other alternatives. The option was maintained to reincorporate measures, if it was warranted by new developments and information.

Marineland is a completely separable reach with only one major damageable structure, and that structure is currently protected by a substantial revetment. Beach-fx modeling of the without-project condition indicates limited damages in this reach, and it is highly unlikely that implementation of any alternatives in this area would be economically justified. Therefore, Marineland was eliminated from further analysis in this study.

The only non-structural measures carried forward other than the no-action plan was buyout and land acquisition, and relocation of SR A1A. These measures could provide potential benefits in the Painters Hill and Beverly Beach reaches where a majority of the shorefront includes a single row of homes east of SR A1A. In Flagler Beach, this measure was screened out because much of the infrastructure is west of SR A1A, and the city has already begun to purchase several of the (few) lots east of SR A1A and designate them as not buildable. FDOT has looked at relocating A1A to an existing secondary street, but the other streets in the area do not have the capability to handle the amount of traffic required of A1A. The main reasons for elimination of the rest of the nonstructural measures were conflicts with state and local regulations and the inability of these measures to contribute to the Federal objectives.

Four structural measures were screened out in the preliminary screening. Nearshore placement could possibly reduce damages, however it is not likely to work as well as beach placement as there is a possibility that the sand may never migrate onto the beach. Emergent breakwaters would likely be less socially acceptable and not as effective for storm damage reduction as other measures, and have been screened out. It is uncertain that PEMs or any type of beach drainage system would be effective in preventing storm damages. The only use of PEMs on the east coast of Florida has been in Hillsboro Beach, Florida where they were placed in 2008. Monitoring reports indicate that the Hillsboro Beach project area functioned similarly to the adjacent control areas, but sand placement directly up-drift of the project was likely to have influenced the results. This technology was presented to Flagler County Commissioners in 2006 as a solution to erosion problems in Flagler Beach and was never pursued. A local grassroots organization called Save Flagler's Beaches supports undercurrent stabilizers as a solution to erosion. Undercurrent stabilizers may not be able to be permitted by the state, and they have not been shown to work in a coastal environment similar to that of Flagler County. Undercurrent stabilizers were presented to Flagler County

commissioners in 2006 as a solution to erosion problems in Flagler Beach. In 2013, the City of Flagler beach funded an analysis evaluating the potential use of undercurrent stabilizers, *City of Flagler Beach, Coastal Avulsion Mitigation and Resurrection [sic] Analysis* (Holmberg, 2013). After receipt of the analysis, the City of Flagler Beach Board of Commissioners unanimously decided not to pursue the use of undercurrent stabilizers further.

The eight structural measures carried forward were seawalls, revetments, sand covered soft structures, beach nourishment, groins, submerged artificial reefs, submerged artificial multi-purpose reefs, and dunes and vegetation. These measures were deemed to have the greatest potential for addressing the planning and Federal objectives while avoiding constraints. Seawalls and revetments are discouraged by the State of Florida unless absolutely necessary and are inconsistent with the state's Coastal Zone Management Plan (CZMP). However, these measures were carried forward because portions of the study area are currently armored with revetments or seawalls, and it may be more acceptable if these measures are implemented in an area where this type of armor already exists and impacts are already occurring. The measures carried forward were further evaluated as the study progressed.

Measures carried forward (unless noted, measures could apply to any reach):

NS-1: No-Action

NS-6: Relocate SR A1A (Flagler Beach reach only)

NS-8: Buyout and Land Acquisition (Painters Hill and Beverly Beach reaches only)

S-1: Seawalls

S-2: Revetments

S-3: Sand Covered Soft Structures

S-4: Beach Nourishment

S-5: Groins

S-6: Submerged Artificial Reefs

S-7: Submerged Artificial Multi-Purpose Reefs

S-10: Dunes and Vegetation

### 5.3.2 Formulation Strategy

Measures, used singularly or in combination with others, create alternatives. Varying scales of each create additional alternatives. An alternative may be implementable for an entire reach or for only a portion of a reach. The combination of management measures results in alternatives that merit further analysis.

Non-Structural (Land Acquisition and Buyout): Basic Combinability

In the Painters Hill and Beverly Beach reaches the nonstructural measure of buyout and land acquisition (NS-8) would be implemented as a standalone alternative. It would not be feasible to construct structural measures to protect structures in the same area where structures have been condemned and removed. **Note:** throughout the study area nonstructural risk reduction measures including education efforts, maintenance of evacuation route signage, zoning codes, and setback requirements were carried forward as elements of any complete systematic package of risk reduction measures. Many of these additional nonstructural efforts are currently being pursued by Flagler County and the City of Flagler Beach and would be performed by local entities alone.

Structural Measures – Basic Combinability

- In the Painters Hill, Beverly Beach, and Flagler Beach reaches sand covered soft structures (S-3) would need to be combined with dunes and vegetation (S-10) as it is a state requirement that soft structures such as geo-tubes remain covered by sand at all times.
- Sand covered soft structures (S-3), seawalls (S-1), and revetments (S-2) are exclusive of each other as they would be constructed along the same footprint. Seawalls (S-1) and revetments (S-2) may be implemented as standalone measures or in combination with other structural measures.
- Groins (S-5) and submerged artificial reefs (S-6) would need to be combined with beach nourishment (S-4) as these two measures would be used to extend nourishment intervals and maximize damage reduction by holding beach sand in place longer without impacting adjacent beaches.
- Beach nourishment, submerged artificial multi-purpose reefs, and dunes and vegetation (S-4, S-7, and S-10) may be implemented either as standalone or in combination with any of the other structural measures.

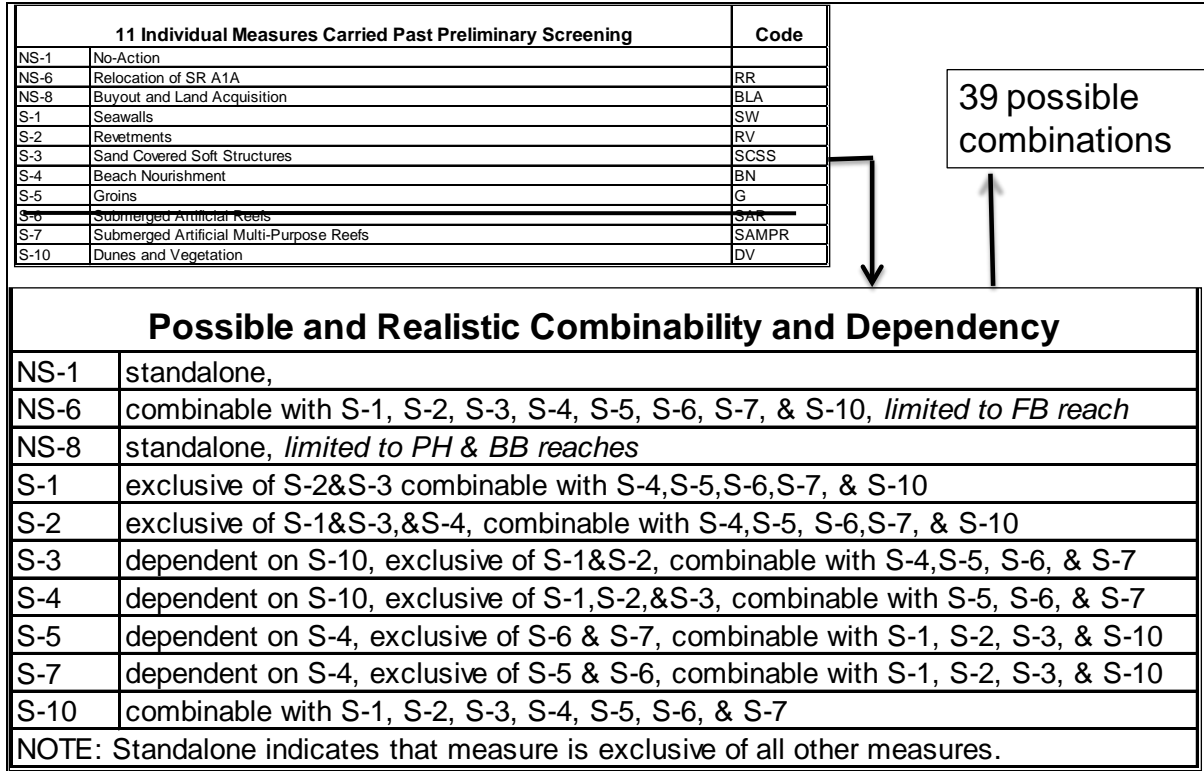
Alternatives were further developed by scaling the management measures in length and size for specific locations. As the alternatives were developed, the evaluation criteria of completeness, effectiveness, efficiency and acceptability were considered. Completeness is satisfied by ensuring that the alternatives include all activities to implement the plan. Effectiveness is determined by how well the alternatives address the project problems. Efficiency is determined by the cost effectiveness of a plan, which is determined through the cost and benefit analysis. Acceptability is determined by evaluating the plan against local, state, and Federal law and policy, and environmental constraints.

Alternatives not meeting the criteria were eliminated. Alternatives which met the criteria were carried forward as alternative plans and underwent further analysis and modeling.

#### 5.3.2.1 Preliminary Screening: Step 2

The initial screening of management measures (described in **Sections 5.2.1, 5.2.2, and 5.2.3**) evaluated 20 structural and nonstructural management measures against the Federal objectives. The individual management measures having the most potential to meet the study objectives were carried forward for further analysis.

Additional combinability and dependency rules were established for the 11 individual measures carried forward. These rules established which measures could or could not be combined with other measures and which measures would be dependent on other measures being implemented. The USACE Institute for Water Resources (IWR) Plan software was used to come up with a list of all combinations of measures based on the established combinability and dependency rules. This resulted in 141 possible combinations of management measures. More detailed combinability and dependency rules were added to reduce this number. Additionally, the Submerged Artificial Reef measure, which would be implemented as a perched beach, was screened out. Initially this measure was considered in order to provide shore protection and keep sand (from beach nourishment) from migrating offshore and covering nearshore hardbottom. It was determined that the perched beach concept would not work to provide shore protection on a long straight coastline like that in Flagler County. Similarly, there was no need to continue consideration of the Submerged Artificial Reef measure because it has minimal potential to meet any of the Federal objectives. This exercise resulted in 39 possible combinations of management measures as shown in **Figure 5-2**.



**Figure 5-2: Possible Combinations of Measures**

Screening with ROM Costs Prior to Beach-*fx*

In order to screen the 39 combinations prior to Beach-*fx* modeling, rough order of magnitude (ROM) cost estimates were developed for each of the individual measures that make up the possible combinations. The ROM cost estimates were developed using information from historical projects. The estimates were based on implementing a measure along one mile of shoreline. It was assumed that it would not be feasible or practical to implement any alternatives along a stretch of shoreline less than 1 mile. These ROM costs were brought to present value (PV) based on maintenance assumptions over 50 years and broken down to a cost per linear foot (LF) of shoreline, shown in **Figure 5-3**.

39 possible combinations		Individual Measures	Code	ROM Estimate (One Time Build) \$/LF	Out Year Assumptions	PV ROM \$/LF	ROM Cost Estimate \$/LF	
		NS-1 No-Action		na	na	na	\$0	
		NS-6 Relocation of SRA1A	RR	\$5,777	na	\$5,777	\$5,777	
		NS-8 Buyout and Land Acquisition	BLA	\$10,077	na	\$10,077	\$10,077	
		S-1 Seawalls	SW	\$5,000	1% maintenance cost every 5 years	\$5,191	\$5,191	
		S-2 Revetments	RV	\$3,300	1% maintenance cost every 10 years	\$3,354	\$3,354	
		S-3 Sand Covered Soft Structures	SCSS	\$1,400	25% maintenance cost every 15 years	\$1,722	\$1,722	
		S-4 Beach Nourishment	BN	\$1,250	Renourishment every 7 years at 100% of first costs	\$4,577	\$4,577	
		S-5 Groins	G	\$4,600	2% maintenance cost every 10 years	\$4,752	\$4,752	
		S-7 Submerged Artificial Multi-Purpose Reefs	SAMPR	\$2,400	25% maintenance cost every 25 years; and 5% every five years	\$3,039	\$3,039	
		S-10 Dunes and Vegetation	DV	\$880	100% maintenance cost every 7 years	\$3,166	\$3,166	
<p><b>Note:</b> Mitigation costs, which typically would be required for hard structures such as seawalls, revetments, and groins, are not included in these ROM cost estimates.</p>								
<p>39 Possible and Realistic Combinations of the 10 Management Measures</p>								
No Action Plan								\$0
RR								\$5,777
BLA								\$10,077
SW								\$5,191
RR&SW								\$10,968
RV								\$3,354
RR&RV								\$9,131
DV								\$3,166
RR&DV								\$8,943
SW&DV								\$8,357
RR&SW&DV								\$14,134
RV&DV								\$6,520
RR&RV&DV								\$12,297
SCSS&DV								\$4,888
RR&SCSS&DV								\$10,665
BN&DV								\$4,577
RR&BN&DV								\$10,354
SW&BN&DV								\$9,768
RR&SW&BN&DV								\$15,545
RV&BN&DV								\$7,931
RR&RV&BN&DV								\$13,708
SCSS&BN&DV								\$6,299
RR&SCSS&BN&DV								\$12,076
BN&G&DV								\$9,329
RR&BN&G&DV								\$15,106
SW&BN&G&DV								\$14,520
RR&SW&BN&G&DV								\$20,297
RV&BN&G&DV								\$12,683
RR&RV&BN&G&DV								\$18,460
SCSS&BN&G&DV								\$11,051
RR&SCSS&BN&G&DV								\$16,828
BN&SAMPR&DV								\$7,616
RR&BN&SAMPR&DV								\$13,393
SW&BN&SAMPR&DV								\$12,807
RR&SW&BN&SAMPR&DV								\$18,584
RV&BN&SAMPR&DV								\$10,970
RR&RV&BN&SAMPR&DV								\$16,747
SCSS&BN&SAMPR&DV								\$9,338
RR&SCSS&BN&SAMPR&DV								\$15,115

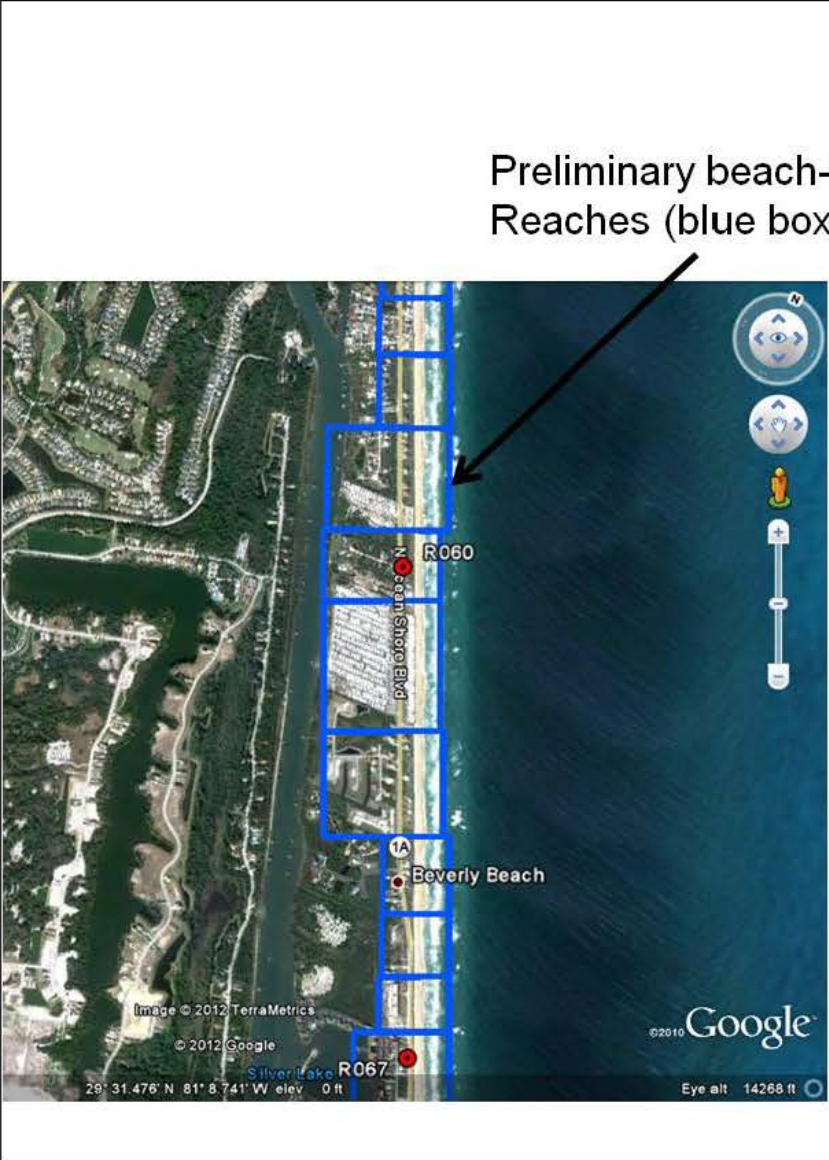
Figure 5-3: ROM Cost Estimates for Possible Combinations of Alternatives



The ROM cost for relocating SR A1A was derived using FDOT input on what it would take to make Central Avenue the new A1A. Central Avenue runs parallel to SR A1A and is located one block landward. The current A1A right-of-way (ROW) is 70 to 100 feet wide, while the Central Ave ROW is approximately 25 feet wide. The ROM cost includes buyout of properties on the east side of Central Avenue at a conservative \$500,000 per developed property, in order to widen the Central Ave ROW. Construction of the new A1A on Central Avenue would require a 3-lane (1 lane in each direction plus a bi-directional lane due to the large number of driveways) urban section which would be comprised of a curb, gutter and 2 to 5-foot wide sidewalks. The estimated construction cost included in the ROM A1A relocation estimate is \$5.5 million per mile. The cost for property buyout and road construction is approximately \$5,777 per linear foot. FDOT noted that this is a very rough estimate that does not include associated design costs or contingency, and the estimate is in no way an acceptance of this concept. It is assumed that due to the scale of the construction, the right-of-way that would be impacted, and increased traffic on what is now designated a local road, gaining consensus on this type of project would pose a significant challenge. In summary, regardless of the cost, it is likely that relocating A1A would not be a practical alternative, and would not be acceptable to residents and local governments. FDOT has stated that they cannot legally abandon A1A to natural erosion and they cannot turn it over to local interests unless the local interests agree to take ownership. Alternatively, if no local interest would accept the road, it could be demolished at an additional expense which is not currently included in the ROM cost. According to the 2010 PD&E Study, "FDOT is committed to protecting SR A1A in its existing location, as this road is a hurricane evacuation route, a designated State Scenic Highway (A1A Ocean Shore Scenic Highway), a National Historic Byway, and provides an economic base for the region."

#### Beach-fx, Future Without-Project Condition, and Sea-Level Change (SLC)

Beach-fx was run for the Future Without-Project (FWOP) condition using each of the three Sea Level Change (SLC) scenarios prescribed by ER 1100-2-8162. The average present value (PV) damage output for each SLC scenario for each Beach-fx reach (blue boxes along the coast in **Figure 5-4**) was divided by the length of the reach to get the value of damages per linear foot (LF).



Preliminary beach-fix Reaches (blue boxes)

Study Reaches	Preliminary Beach-fix Reaches	R- monument vicinity	Reach Length (LF)	PV Damages and Costs \$/LF SLC1	PV Damages and Costs \$/LF SLC2	PV Damages and Costs \$/LF SLC3
Painters Hill	PH-1	R05 0-R050	662.66	\$71	\$109	\$470
	PH-2	R05 1-R052	934.64	\$5,126	\$6,247	\$7,323
	PH-3	R05 2-R053	625.76	\$2,815	\$3,088	\$3,391
	PH-4	R05 3-R054	1071.00	\$2,655	\$3,443	\$4,372
	PH-5	R05 5-R055	1063.12	\$1,219	\$1,320	\$1,250
	PH-6	R05 6-R056	706.77	\$7,182	\$12,139	\$13,378
	PH-7	R05 6-R057	770.19	\$147	\$477	\$629
	PH-8	R05 7-R058	984.70	\$10	\$26	\$52
	PH-9	R05 8-R059	1396.21	\$26	\$96	\$133
	PH-10	R06 0-R060	953.10	\$40	\$664	\$1,221
Beverly Beach	BB-1	R06 1-R062	1759.06	\$4	\$20	\$277
	BB-2	R06 2-R064	1435.70	\$55	\$157	\$194
	BB-3	R06 4-R065	1055.07	\$13	\$74	\$574
	BB-4	R06 5-R066	836.34	\$166	\$2,260	\$5,295
	BB-5	R06 6-R067	755.17	\$185	\$2,570	\$5,721
Flagler Beach	FB-1	R06 7-R068	1429.04	\$105	\$971	\$3,435
	FB-2	R06 8-R069	811.02	\$157	\$2,165	\$5,764
	FB-3	R06 9-R070	1177.50	\$328	\$2,311	\$5,589
	FB-4	R07 0-R071	1035.78	\$506	\$4,590	\$7,136
	FB-5	R07 1-R072	1032.76	\$285	\$3,130	\$4,752
	FB-6	R07 2-R074	1231.49	\$185	\$2,206	\$3,405
	FB-7	R07 4-R075	1324.08	\$78	\$1,298	\$2,619
	FB-8	R07 5-R076	941.27	\$104	\$3,038	\$5,117
	FB-9	R07 6-R077	888.27	\$319	\$3,375	\$5,653
	FB-10	R07 7-R078	1255.43	\$268	\$1,756	\$4,517
	FB-11	R07 8-R079	1039.51	\$279	\$1,301	\$3,428
	FB-12	R07 9-R080	717.90	\$650	\$2,382	\$7,825
	FB-13	R08 0-R081	1043.75	\$1,213	\$3,108	\$4,693
	FB-14	R08 1-R082	907.38	\$1,024	\$4,910	\$8,288
	FB-15	R08 2-R083	1290.12	\$139	\$1,595	\$3,165
	FB-16	R08 3-R085	1292.29	\$2,285	\$4,049	\$5,897
	FB-17	R08 5-R085	679.82	\$6,610	\$8,794	\$11,199
	FB-18	R08 6-R086	861.36	\$8,238	\$11,134	\$14,249
	FB-19	R08 6-R087	660.22	\$11,989	\$14,296	\$16,508
	FB-20	R08 7-R088	658.31	\$7,722	\$9,144	\$10,692
	FB-21	R08 8-R089	691.38	\$7,336	\$9,293	\$11,412
	FB-22	R08 9-R090	1188.91	\$5,081	\$6,439	\$8,365
	FB-23	R09 0-R091	1304.00	\$2,976	\$4,066	\$6,272
	FB-24	R09 2-R092	919.66	\$2,459	\$3,449	\$5,334
	FB-25	R09 2-R093	1030.97	\$1,202	\$3,249	\$6,199
	FB-26	R09 4-R095	1352.89	\$1,547	\$2,317	\$3,653
	FB-27	R09 5-R096	777.84	\$0	\$0	\$41
	FB-28	R09 6-R097	1137.18	\$315	\$415	\$799
	FB-29	R09 7-R098	839.42	\$207	\$580	\$1,748
	FB-30	R09 8-R099	1299.01	\$993	\$3,829	\$6,091
	FB-31	R09 9-R000	1643.13	\$70	\$1,393	\$4,617

Figure 5-4: Present Value Damages divided by shoreline length (\$/linear foot) for the three SLC scenarios (SLC1, SLC2, SLC3)

A project's benefit-to-cost ratio (B/C ratio) must be greater than 1.0 in order for an alternative to be justified and implementable (i.e., the benefits must be greater than the costs). Benefits equal damages prevented, or the difference between without-project damages and damages resulting after implementation of an alternative. At this point in the study, alternatives had not been formulated, so no "with project" Beach-fx scenarios were able to be run. Until management measures are scaled, or combined, to form alternatives, damages are used as a proxy for benefits. Using the value of without-project damages as a substitute for the benefits will overestimate the benefit provided by any measure since this assumes that 100 percent of damages have been averted. Therefore if the cost of implementing a measure is equal to, or less than, the without-project damages, the B/C ratio can be assumed to approximate 1 and the measure may be justified. **Figure 5-5** displays the costs per linear foot of measures in addition to damages along the shoreline for each of the three SLC scenarios. Wherever damages were far below a measure's implementation costs, it was assumed that the measure would not be justified along that shoreline length and the measure was screened out. Where damages are near or above ROM costs along a stretch of shoreline of sufficient length for an alternative to be realistically implemented, it was assumed that the measure was justified and was carried forward. This comparison not only helps in screening, but it also serves to scale measures that are carried forward, illustrating the shoreline lengths that may have enough FWOP damages to justify implementation of a project.

The cost of a measure's implementation may vary depending on the SLC scenario used for design. Because of this it is important to note that there is uncertainty around future costs, and measures with costs just above projected damages should not be screened out prematurely. Beach nourishment (S4), for example, will have a higher cost for higher SLC scenarios because more sand or shorter renourishment intervals would be required. Other measures may have the same implementation cost for any scenario.

In **Figure 5-5**, damages are shown for each preliminary Beach-fx reach from Painters Hill through Flagler Beach. On the horizontal axis "PH-1" is the northernmost reach in Painters Hill, "FB-1" is the northernmost reach in Flagler beach, "FB-31" is the furthest south reach at the Volusia County line. Straight horizontal lines are the ROM costs for combinations of management measures. The damages include both damages to infrastructure (roads and houses), as well as costs for replacing and constructing armor as it is damaged or triggered in the model.

Many combinations had ROM costs that far exceed the expected damages along lengths of shoreline of sufficient length to realistically implement an alternative and were screened out.

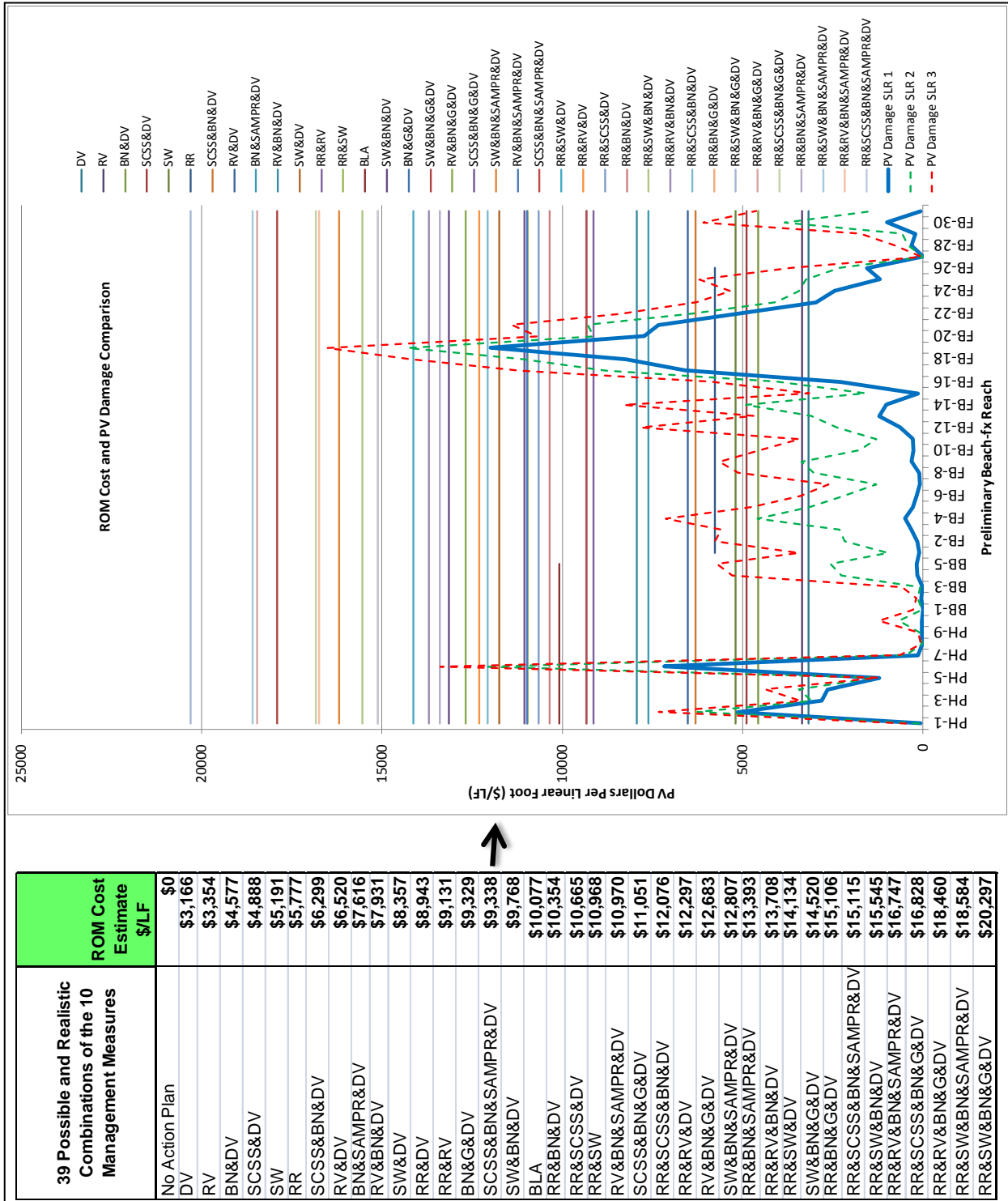
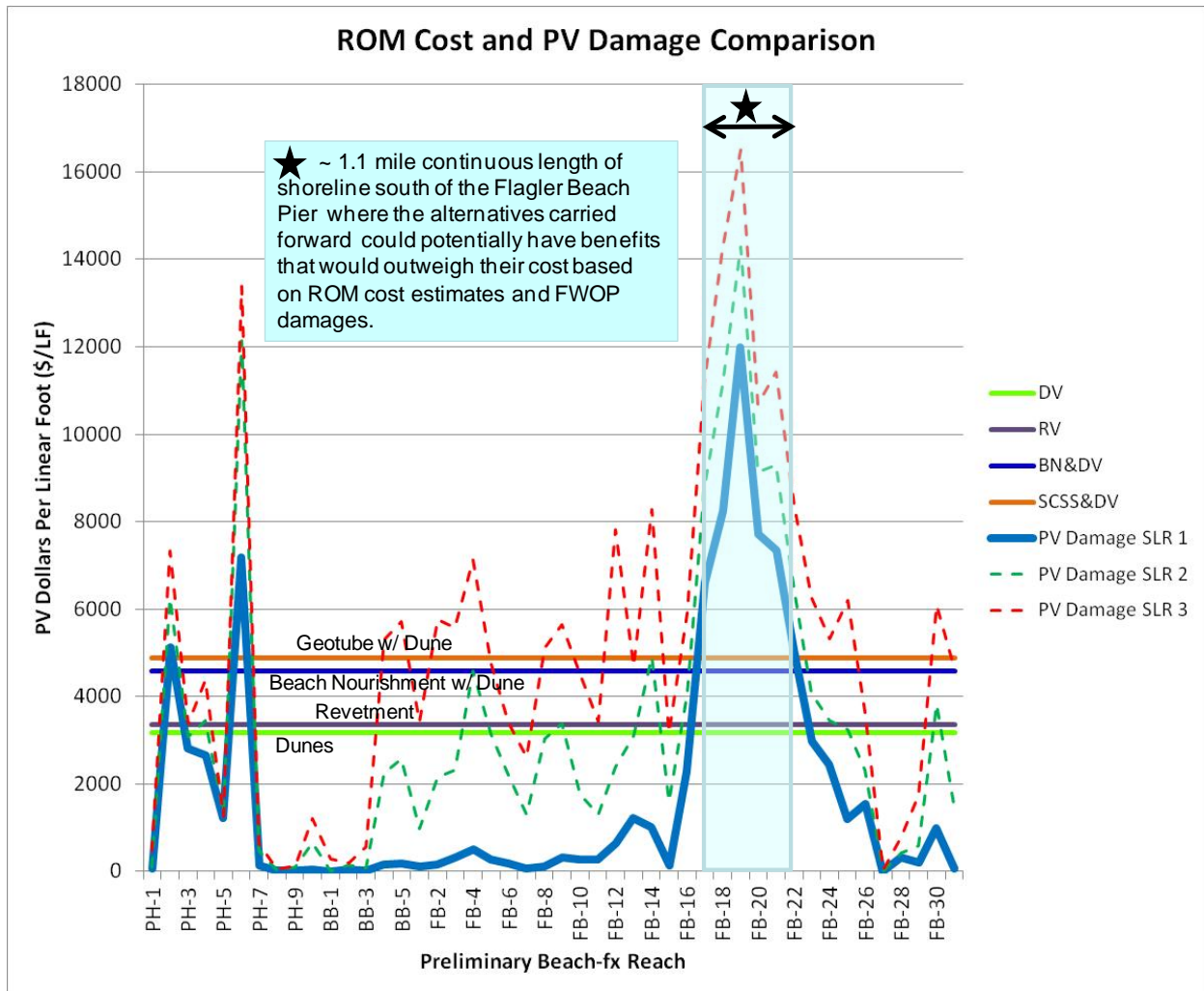


Figure 5-5: Present Value Damages for the three SLC scenarios vs ROM costs

This step resulted in five measures carried forward to intermediate screening as shown in **Figure 5-6**:

- No-action
- Geotube with Dune
- Revetment
- Dunes
- Beach Nourishment with Dune

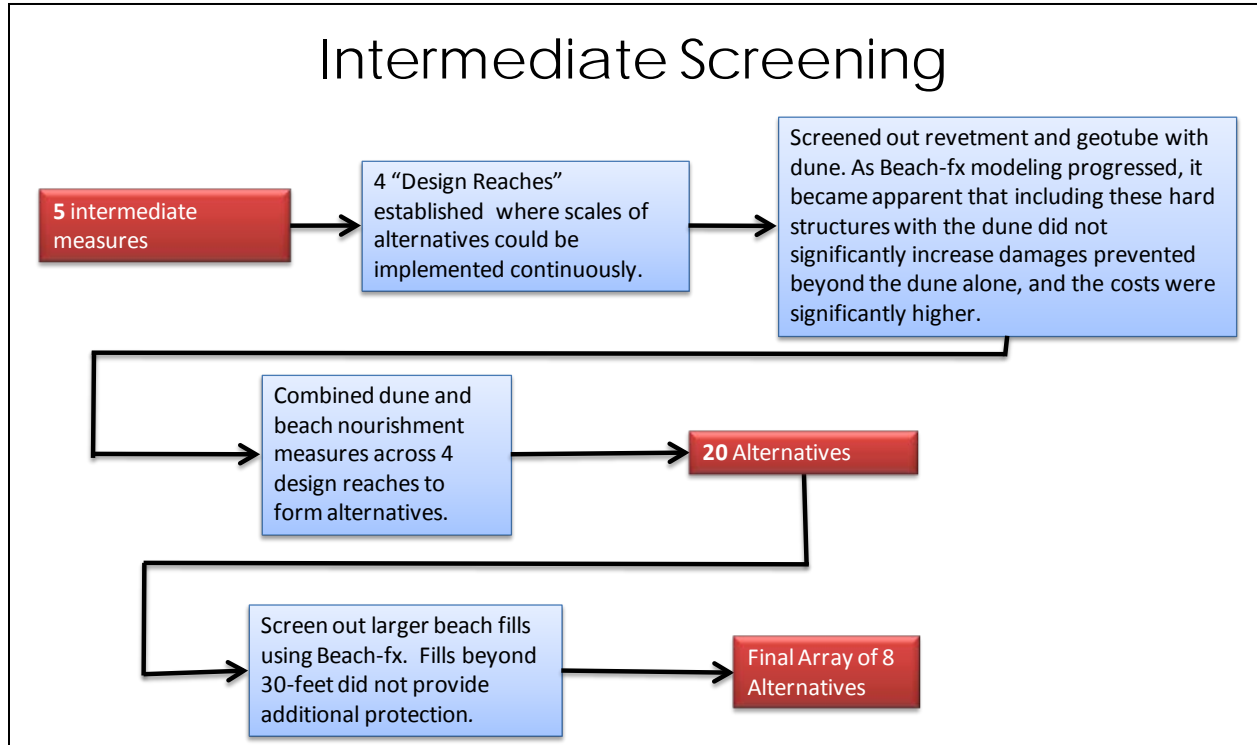


**Figure 5-6: Present Value Damages vs ROM Costs for the alternatives being carried forward to intermediate screening**

### 5.3.3 Intermediate Screening

**Figure 5-7** shows the methodology for intermediate screening. The five remaining measures were evaluated in four design reaches. These remaining measures are referred to as “alternatives” from this point forward. Beach-fx was then used to evaluate

Future With-Project (FWP) damages. Comparing “future without” to “future with” project damages results in the damage prevention provided by the alternative. Damage prevention is equivalent to storm damage reduction benefits. From here, a final array of alternatives was established.



**Figure 5-7: Intermediate Screening Flow Chart**

The five alternatives carried forward into the intermediate screening phase showed the greatest potential to feasibly achieve planning objective #1 to reduce damages to structures and infrastructure in the study area based on ROM cost estimates. **Table 5-7** shows how these five alternatives either met or fail to meet all four of the planning objectives described in **section 4.7**. As this is a single purpose project for hurricane and storm damage reduction, planning objectives # 2, # 3, and #4 are secondary to planning objective #1. However, all three objectives were considered throughout the formulation process, as were the Environmental Operating Principles, Executive Order 11988, and the criteria of completeness, effectiveness, efficiency, and acceptability.

The **no-action alternative** does not meet any of the planning objectives because it does not address any specific problems. It provides a comparison for all other alternatives.

The revetment only alternative would be constructed similarly to the revetment that exists in Marineland, and would provide much greater protection than the existing FDOT revetment along SR A1A. This alternative would meet objective # 4 by protecting the

evacuation route, but it does not meet objectives # 2 and # 3 because beach erosion would likely continue or intensify from wave reflection off the revetment during storms and down drift impacts, resulting in loss of habitat and recreational opportunities. Without any mitigation, this alternative may not be consistent with the Environmental Operating Principles because it would not foster unity of purpose on environmental issues. This alternative would not violate EO 11988 by encouraging new development in a floodplain, but rather would serve to protect existing development. As alternative development progressed, it became apparent that a **revetment with dune nourishment alternative** needs to be considered, rather than revetment only, in order to keep the structure covered and not impact sea turtle nesting and to offset down drift erosion impacts. This is due to the fact that the revetment alternative would have a much larger footprint than the existing FDOT revetment in order to provide a significant reduction in damages.

The **geotube with dune, dunes, and beach nourishment with dune** alternatives meet all four of the planning objectives. They all have outputs consistent with the Environmental Operating Principles because they foster unity of purpose on environmental issues. None of these alternatives would violate EO 11988 by encouraging new development in a floodplain, but rather would serve to protect existing development.

**Table 5-7: Intermediate Alternatives and Planning Objectives**

<b>Alternatives</b>	<b>Planning Objective #1</b> <i>Reduce storm damages to structures and infrastructure</i>	<b>Planning Objective #2</b> <i>Maintain environmental quality in the project area and adjacent areas</i>	<b>Planning Objective #3</b> <i>Maintain opportunities for recreational use of beach and nearshore areas</i>	<b>Planning Objective #4</b> <i>Maintain safe hurricane evacuation route</i>
No-Action	<b>Does not meet.</b> No improvement made to reduce damages.	<b>Does not meet.</b> Loss of the already minimal beach berm and dune habitat would continue.	<b>Does not meet.</b> Loss of the already minimal recreational beach berm would continue.	<b>Does not meet.</b> The existing evacuation route would continue to be damaged and emergency repairs would continue to be needed to keep the route open.
Geotube with Dune	<b>Meets.</b> Damages landward of the geotubes would be reduced.	<b>Meets.</b> Dune and beach habitat would be maintained as long as the geotube remains buried in the dune.	<b>Meets.</b> Recreational beach would be maintained as long as the geotube remains buried in the dune.	<b>Meets.</b> Damages to the road would be reduced allowing for a safe evacuation route.
Revetment Only	<b>Meets.</b> Damages landward of the revetment would be reduced.	<b>Does not meet.</b> Negative impacts on sea turtle nesting. Not aesthetically appealing.	<b>Does not meet.</b> Reflected wave energy off the revetment will likely intensify erosion of the recreational beach berm.	<b>Meets.</b> Damages to the road would be reduced allowing for a safe evacuation route.
Dunes	<b>Meets.</b> Damages landward of the dune would be reduced.	<b>Meets.</b> Dune and beach habitat would be maintained.	<b>Meets.</b> Recreational beach would be maintained.	<b>Meets.</b> Damages to the road would be reduced allowing for a safe evacuation route.
Beach Nourishment with Dune	<b>Meets.</b> Damages landward of the beach and dune would be reduced.	<b>Meets.</b> Dune and beach habitat would be maintained.	<b>Meets.</b> Recreational beach would be maintained.	<b>Meets.</b> Damages to the road would be reduced allowing for a safe evacuation route.

As the study progressed into intermediate screening, reaches along the shoreline were regrouped according to modeled damages and existing shoreline conditions rather than the political boundaries of Painter’s Hill, Beverley Beach, and Flagler Beach. **Figure 5-8** shows how the new “design reaches” (described in the next section) relate to R-monuments, study reaches, and preliminary Beach-fx reaches. Beach-fx model reaches were designated to correspond to the design reaches as shown in **Figure 5-8**.



Figure 5-8: Reach designations and alignments

REACH NOMENCLATURE BY PLANNING PHASE – FLAGLER COUNTY HSDR PROJECT																																																									
Reach Designation	Planning Phase	R-1	R-2	R-3	R-4	R-50	R-51	R-52	R-53	R-54	R-55	R-56	R-57	R-58	R-59	R-60	R-61	R-62	R-63	R-64	R-65	R-66	R-67	R-68	R-69	R-70	R-71	R-72	R-73	R-74	R-75	R-76	R-77	R-78	R-79	R-80	R-81	R-82	R-83	R-84	R-85	R-86	R-87	R-88	R-89	R-90	R-91	R-92	R-93	R-94	R-95	R-96	R-97	R-98	R-99	R-100	R-101
Study Reach	Existing Conditions	Marine-land				Painters Hill					Beverly Beach					Flagler Beach																																									
RUN PRELIMINARY BEACH-FX TO DETERMINE FUTURE WITHOUT-PROJECT (FWOP) CONDITIONS																																																									
Preliminary Beach-fx Reach	Future Without-Project Conditions	ML-1 to ML-4				PH-1 to PH - 10					BB-1 to BB - 5					FB-1 to FB - 31																																									
REACHES GROUPED BY SIMILAR FUTURE WITHOUT-PROJECT INFRASTRUCTURE DAMAGE CHARACTERISTICS																																																									
Design Reach	Plan Formulation	N/A				Reach A					Reach B					Reach C					Reach D																																				
RUN BEACH-FX ALTERNATIVE ANALYSIS																																																									
Beach-fx Model Reach	Plan Formulation	N/A				RA-1 to RA-10					RB-1 to RB-17					RC-1 to RC-14					RD-1 to RD-5																																				

### 5.3.3.1 Intermediate Screening: Step 1

Four Beach-fix design reaches were created based on average present value (PV) damages of the FWOP condition (see **Figure 5-9**), as well as existing shoreline conditions such as existing beach width and profile. In **Figure 5-9**, the continuous horizontal segments of the solid lines indicate the PV damages per linear foot throughout the four design reaches for the 3 SLR scenarios prescribed by ER 1100-2-8162.

- Design Reach-A includes Painters Hill and is a 1.7-mile long segment (R50 to R60). Much of this reach is an unarmored bluff with one row of single family oceanfront homes east of SR A1A.
- Design Reach-B includes Beverly Beach and the northern portion of Flagler Beach and is a 3.5-mile long segment (R60 to R80). The shorefront consists of a steep, mostly unarmored bluff with varying amounts of vegetated dune between SR A1A and the beach berm. A salient (seaward extension of the beach) exists in the berm on both sides of the pier.
- Design Reach-C includes central Flagler Beach and is a 2.6-mile long segment (R80 to R94). The shorefront to the south of the pier consists of a steep bluff armored with mostly granite and some coquina rock revetment and a 150-foot section of steel seawall immediately east of SR A1A.
- Design Reach-D includes south Flagler Beach and is a 1-mile long segment (R94 to R101). The shorefront consists of a steep, unarmored bluff with varying amounts of vegetated dune between SR A1A and the beach berm. In the middle of this design reach there is a half mile stretch where SR A1A curves slightly inland and there are four structures east of SR A1A which are armored with old wooden and concrete seawalls. There are also several parking and bath facilities east of SR A1A in Gamble Rogers State Park fronted by a steep vegetated dune system.

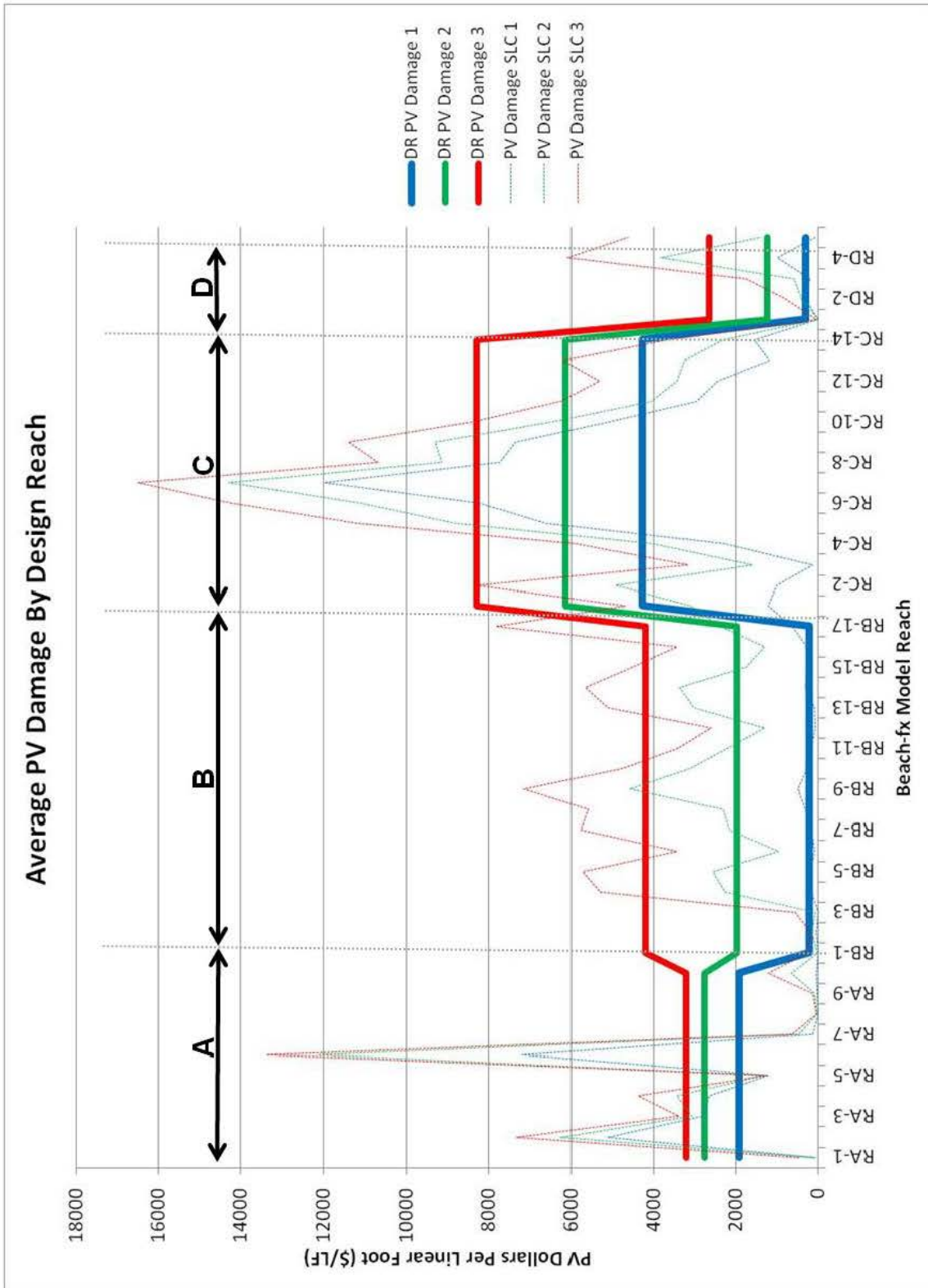


Figure 5-9: Average PV damages per linear foot for the three SLC scenarios throughout the four design reaches

As Beach-fx modeling progressed, it became apparent that including either a revetment or geotube with the dune would not significantly reduce damages beyond the dune alone, and the costs would be significantly higher. Therefore, the **revetment with dune** and **geotube with dune alternatives** were screened out, and the alternatives to be modeled further included combinations of the **dune and beach nourishment alternatives**.

**Figure 5-10** depicts the average present value FWOP damages for the four design reaches compared to the ROM cost estimates of the alternatives carried forward. In **Figure 5-10**, “Beach X 4” means that four separate widths of beach nourishment were modeled in Beach-fx: 20-foot, 40-foot, 60-foot, and 80-foot widths. This resulted in 30 alternatives to be evaluated in Beach-fx throughout the project area.

Although the ROM costs exceed the damages for the low and intermediate SLC scenarios in all of the design reaches except C, all the design reaches were modeled to capture benefits for adjacent nourishments that could affect erosion rates.

These Beach-fx model runs result in Future With-Project (FWP) damages. Comparing “future without” to “future with” project damages results in the damage prevention provided by the alternative. Damage prevention is equivalent to storm damage reduction benefits.

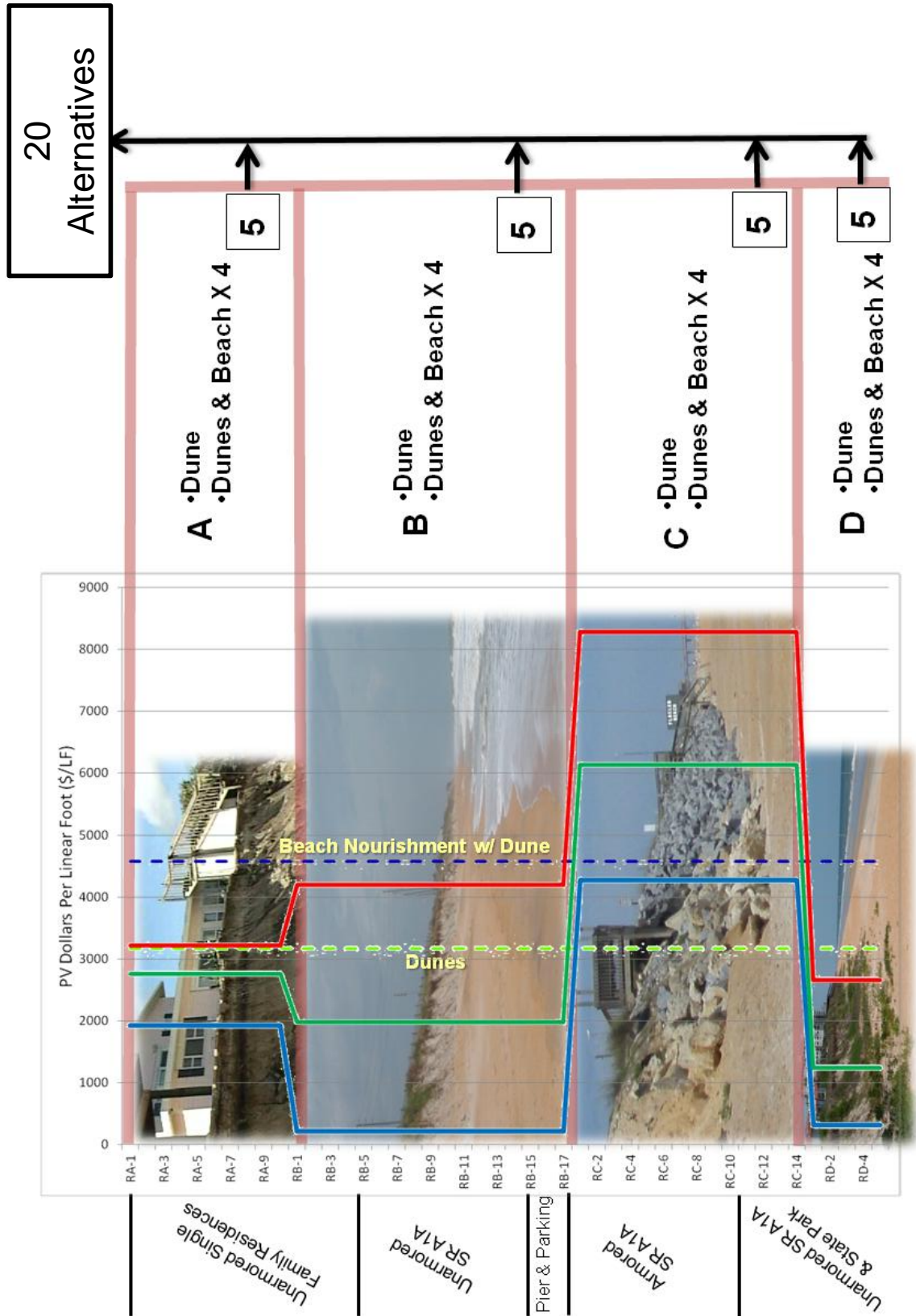


Figure 5-10: Design Reaches and Alternatives to be modeled.

### 5.3.3.2 Intermediate Screening: Step 2

ER 1100-2-8162 directs that alternatives should be adaptable to potential SLC scenarios across the planning horizon. In **Figure 5-11**, the alternatives are symbolized by colored bars spanning increments of Sea-Level Rise (SLR). The length of the colored bars indicates each alternative's robustness and adaptability as sea level increases. Each alternative has a beginning and ending threshold. The beginning threshold may not be immediate but at some time in the future when sea level reaches a point which makes the alternative acceptable for environmental, economic, social or other reasons. The ending threshold indicates a sea-level height where the alternative no longer functions or can no longer be adapted to provide storm damage reduction. In between these thresholds the alternative can be adapted as sea level increases. Adaptability is dependent on relative sea level and is independent of specific SLC scenarios. The different SLC scenarios only impact the future point in time when the sea level is reached that corresponds to an alternative's thresholds. Some alternatives that have start thresholds above RSL=0 will require lead times to coordinate with agencies and the public.

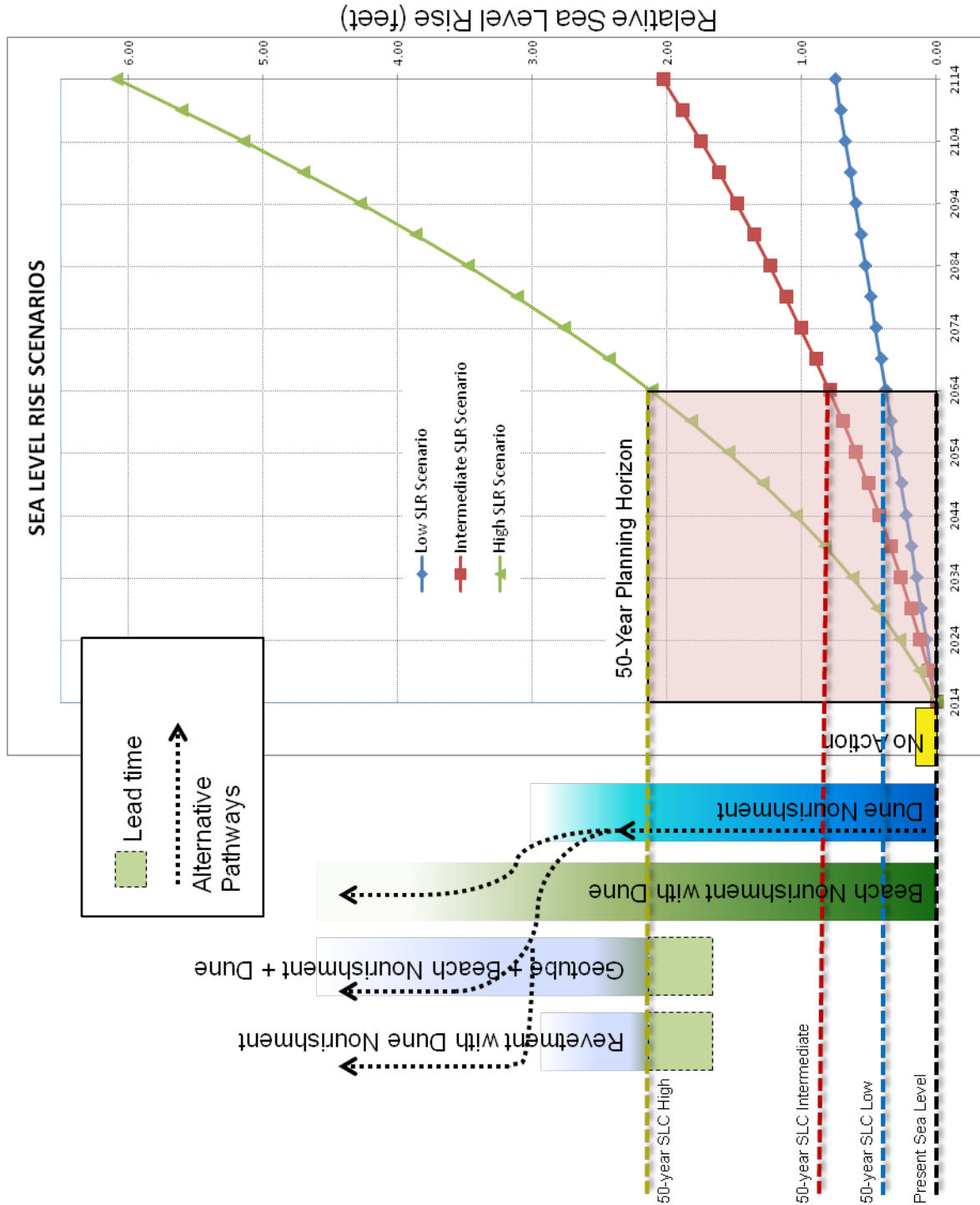


Figure 5-11: Alternative adaptability to SLC scenarios prescribed by ER 1100-2-8162.

**No Action:** Based on without-project Beach-fx simulations, damages increase dramatically between 2025 and 2030 under the low SLC curve (see the **Economic Appendix**). In **Figure 5-11**, this would correspond to an approximate 0.25 foot increase in the present sea level. Therefore 0.25 feet is shown as the ending threshold for No Action. This alternative is most sensitive to the background erosion rate. The intermediate and high SLC scenarios cause a proportional increase in background erosion and therefore would cause the No-action project damages to increase even sooner than the low SLC scenario. This alternative is not feasible under any SLC scenario.

**Dune Nourishment:** This alternative is implementable at current sea level. The dune nourishment alternative consists of a 10-foot seaward extension of the dune and beach profile out to the depth of closure. The depth of closure is the most landward depth seaward of which there is no significant change in bottom elevation and no significant net sediment transport between the nearshore and the offshore for a given or characteristic time interval. It can be applied over a single project reach or multiple project reaches. Over a 50-year project life, it is estimated that the total fill volume required for this alternative would fall between a minimum of 610,000 cubic yards (Reach A only, low SLC scenario) and a maximum of 9,900,000 cubic yards (Reaches A, B, C, and D high SLC scenario). Presently, three borrow sites, 2A, 2B, and 2C, have been identified as immediate sources of fill material. Combined, the three primary sites have an available volume of 5,600,000 cubic yards of beach quality material. A fourth borrow site, 3A, has been identified as a future borrow site. Site 3A has an estimated available volume of 20,000,000 cubic yards. Taking all four borrow sites into account, there is sufficient volume to support dune nourishment for all project reaches over the full 50-year life of the project. This alternative is adaptable across all SLC scenarios for at least the 50-year period of analysis.

**Dune and Beach Nourishment:** This alternative is implementable at current sea level. The dune and beach nourishment alternative consist of a 10-foot seaward extension of the dune and a 20-foot to 80-foot extension of the berm. Over a 50-year project life, it is expected that the total fill volume required for a dune and beach nourishment would fall between 1,330,000 cubic yards (Reach A, 10-foot dune and 20-foot berm extensions, low SLC scenario) and 42,190,000 cubic yards (Reach A, B, C, and D 10-foot dune and 80-foot berm extension, high SLC scenario). While the combined volume of beach quality material available from the identified borrow sites is sufficient to maintain a smaller (20-foot to 40-foot) berm extension in a single reach over a 50-year project life, combined reach cases and larger fill alternatives (60-foot to 80-foot berm extensions) would rapidly exhaust all of the identified borrow sites. Therefore, unless additional sand sources are identified, only a 20-foot to 40-foot berm extension (combined with a 10-foot dune extension) would be feasible throughout and beyond the 50-year project life. Depending on the size of the berm constructed, this alternative is not necessarily adaptable across all SLC scenarios for the 50-year period of analysis. In **Figure 5-11**, the ending threshold is beyond the 50-year planning horizon to reflect that smaller berms may be adaptable or additional sand sources may be found.



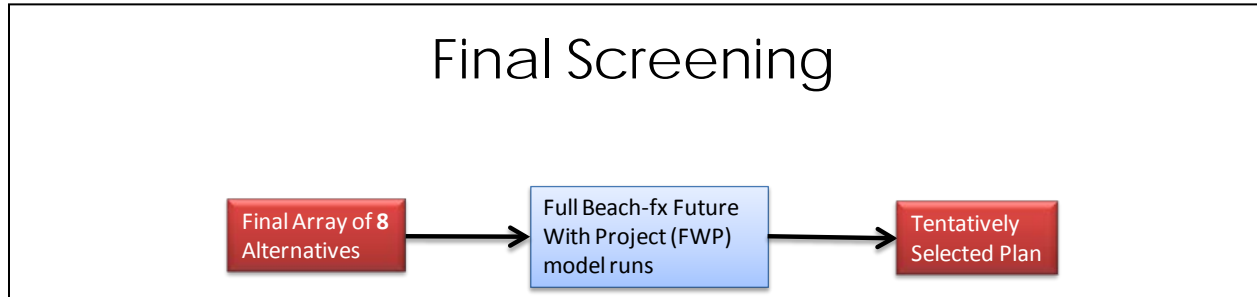
The Beach-fx model employed to determine damages for each design case can only consider climate change impacts through sea-level rise and corresponding changes to shoreline erosion rates. Storm frequency and intensity remain constant. It is possible in the future that climate change will result not only in accelerated sea-level change, but also change the frequency and intensity of the storm conditions that impact the project shoreline. Should there be an intensification or increase in storm activity, it is possible that a dune and beach nourishment alternative would become more practical than a dune nourishment alone. Therefore, it is possible that a dune nourishment could transition into a dune and beach nourishment at a time beyond the projected 50-year project life. The “alternative pathway” in **Figure 5-11** reflects this.

Revetment with Dune Nourishment: This alternative is not currently implementable. Presently a majority of the Flagler shoreline is protected by an existing revetment that is in relatively poor condition with rock that is not all sized appropriately. The previously discussed dune nourishment would cover the revetment to avoid sea turtle nesting concerns. The revetment with dune nourishment alternative differs from the dune nourishment alternative only in that a robust revetment would be installed where the more simple revetment presently exists. Being significantly more expensive than the dune alternative, this alternative would not be desirable until climate change altered sea level and incident storm conditions to a degree that reinforcement of the dune alternative with a robust revetment is necessary to maintain adequate protection to A1A and other infrastructure. Currently, predicted damages would not justify construction of this alternative unless the high SLC curve is realized. Therefore this alternative is not currently implementable given that the much less expensive dune only alternative prevents the majority of predicted damages. It is assumed that the implementation threshold for this alternative would be when the dune only alternative is no longer able to provide adequate protection. For planning purposes, the ending threshold is assumed to be at a time beyond the 50-year planning horizon when it becomes impractical to maintain sand cover over the revetment.

Dune with Geotube Core and Beach Nourishment: This alternative is not currently implementable. Like the revetment with dune nourishment alternative, this alternative also requires an extension of the dune sufficient to completely cover a sand filled geotube core. This alternative has the same beginning threshold as the revetment alternative. For planning purposes, the ending threshold would be approximately the same as the beach nourishment with dune alternative with the added problem of needing to maintain sand cover over the geotube core. Other such geotube projects in Florida indicate that it is difficult to maintain sand cover and as the geotubes are exposed they are highly susceptible to damage from both natural environmental conditions and through vandalism.

5.3.4 Final Screening

**Figure 5-12** shows the methodology for final screening. Additional Beach-fx runs of the beach nourishment alternatives indicated that berm extensions greater than 30-feet did not prevent a significant amount of additional damages. Therefore, the **dune** and **beach nourishment** alternative was refined by eliminating the 50 and 70-foot widths but maintained for consideration of the 10 and 30-foot widths.



**Figure 5-12: Final Screening Flow Chart**

A key aspect of the Flagler County study is that each study reach (A,B,C,D) is treated as a separable element. Between the two remaining alternatives and the four study reaches, eight fully developed alternatives were carried forward to be modeled in Beach-fx, representing a reasonable number of project alternatives for evaluation. The naming convention for the alternatives is described below. In **Table 5- 8**, “dune width” is equivalent to the approximate dune crest width. All berm widths are measured from the seaward toe of the 10-foot dune extension. The letter “H” in the alternative names represents that the alternative would be constructed using hydraulic dredging methods from an offshore borrow area.

**Table 5-8: Final Array of Design Alternatives**

Design Alternative	Description	Dune Height Extension (ft)	Dune Width Extension (ft)	Berm Width Extension (ft)
Reach A duneH	10-foot extension of the existing ReachA dune and beach profile	0	10	0
Reach A 30	Extension of ReachA dune and berm	0	10	20
Reach B duneH	Extension of ReachB dune	0	10	0
Reach B 30	Extension of ReachB dune and berm	0	10	20
Reach C duneH	10-foot extension of the existing ReachC dune and beach profile	0	10	0
Reach C 30	Extension of ReachC dune and berm	0	10	20
Reach AC duneH	10-foot extension of the existing ReachA + ReachC dune and beach profile	0	10	0
Reach AC 30	Extension of ReachA + ReachC dune and berm	0	10	20

Other combinations were considered during the plan formulation process. However, preliminary modeling indicated that the other alternatives would not be economically justified. For example, an ABC-Dune-H alternative was screened out because Reach B, which is a separable element, is not economically justified. The same is true for ABCD, as both the B and D segments are not incrementally justified. Larger beach nourishment alternatives were also considered. In every reach, the construction and maintenance of a wider berm (50 feet, 70 feet, etc.) generates few, if any additional benefits, while incurring significant increases in total project cost. In fact, most of the larger beach nourishment alternatives had costs that were greater than all of the damages in the FWOP condition. Even if such a project eliminated 100% of the damages, it would still not be economically justified.

### 5.3.5 Alternative Comparison

All the alternatives described above were modeled in Beach-fx using full (100 iterations) life-cycle simulations. The results of these simulations were used to select the NED Plan. The results of the alternative comparison are presented in **Table 5-9**. Additional detail is provided in the **Economics Appendix**.

**Table 5-9: AAEQ Benefits and Costs for Final Array of Alternatives**

Alternatives	Brief Description	Benefits	Cost	Net Benefits	BCR
<b>Reach A duneH</b>	Dune extension and 10' sacrificial berm in Reach A only	\$220,000	\$170,000	\$52,000	1.35
<b>Reach A 30</b>	Dune extension and 30' sacrificial berm in Reach A only	\$690,000	\$700,000	-\$16,000	0.98
<b>Reach B duneH</b>	Dune extension and 10' sacrificial berm in Reach B only	\$200,000	\$250,000	-\$57,000	0.78
<b>Reach B 30</b>	Dune extension and 30' sacrificial berm in Reach B only	\$210,000	\$1,030,000	-\$809,000	0.21
<b>Reach C duneH (NED)</b>	Dune extension and 10' sacrificial berm in Reach C only	\$2,190,000	\$810,000	\$1,387,000	2.72
<b>Reach C 30</b>	Dune extension and 30' sacrificial berm in Reach C only	\$2,250,000	\$1,180,000	\$1,065,000	1.90
<b>Reach AC duneH</b>	Dune extension and 10' sacrificial berm in Reaches A and C (non-contiguous)	\$2,940,000	\$1,130,000	\$1,814,000	2.61
<b>Reach AC 30</b>	Dune extension and 30' sacrificial berm in Reaches A and C (non-contiguous)	\$2,960,000	\$1,750,000	\$1,206,000	1.69

<sup>†</sup> Costs were developed by SAJ District Cost Engineering personnel in FY2013 dollars, and deflated back to 2011 price levels. The original real estate assessment was completed in 2011, so the benefits are in 2011 price levels.

The criteria of completeness, effectiveness, efficiency, and acceptability were considered in order to determine if a plan is worthy of further consideration. The final array of alternatives consist of dune and beach nourishment at various scales. None of the alternatives require substantial activity by others that are not likely to be forthcoming, in order to meet the objectives. Therefore, all of the final alternatives equally meet the criteria of completeness. All of the final alternatives equally meet the criteria of effectiveness because they meet all the planning objectives. This is shown in **Table 5-7**. The criteria of efficiency is best met by alternatives **Reach AC duneH and Reach C duneH** which have the highest net benefits and BCR respectively. The rest of the alternatives in the final array are not efficient because they do not meet the objective to maximize net benefits relative to cost. In order to be considered acceptable, an alternative must be workable and viable with respect to acceptance by the state, local entities, the public, and compatibility with existing laws, regulations, and public policies. Alternatives that include reach A do not meet the acceptability criteria because for all intents and purposes reach A is a private beach, and not publicly accessible per current USACE policy. For this reason reach A is screened out.

With **Reach AC duneH** screened out, the NED Plan with the highest net benefits and BCR is **Reach C duneH**.

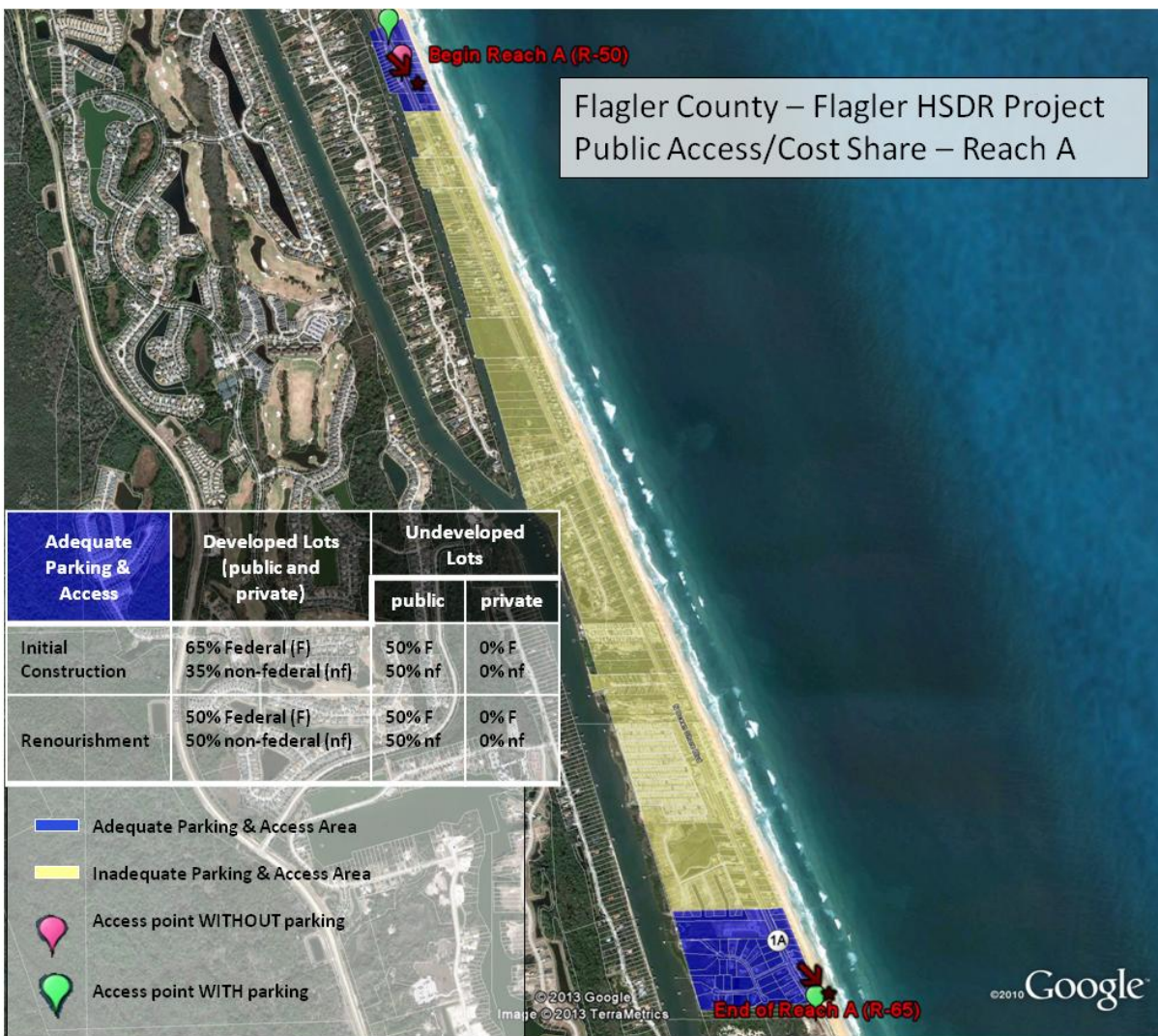
The benefits for alternatives with multiple reaches are not simply the additive benefits of the alternatives for the individual reaches combined. For example, the benefits for **Reach AC dune H** are not just the added benefits of the **Reach A dune H** and **Reach C dune H** alternatives. The construction of a berm and/or dune results in direct benefits to the segment receiving the nourishment; it also results in supplemental benefits to down-drift segments. A down-drift segment could be either north or south of a constructed fill. The net transport in the project area is north to south, but the instantaneous direction will vary depending on meteorological conditions. For example, the nourishment in Reach A actually improves the performance of the dune constructed in Reach C.

The assessment of the future-without project conditions identified additional planning opportunities that were integrated into the formulation as secondary planning objectives. Consequently the NED plan produces benefits that fall within the three other P&G accounts that the FDOT reactive maintenance does not address. These project specific objectives included the need to increase the reliability of A1A as a critical emergency evacuation route that produce other social effects account benefits; identify opportunities to provide additional critical beach habitat that has degraded in the study area due to coastal erosion that produces environmental quality account benefits; and maintain the local economy through recreational opportunities that produces regional economic development account benefits.

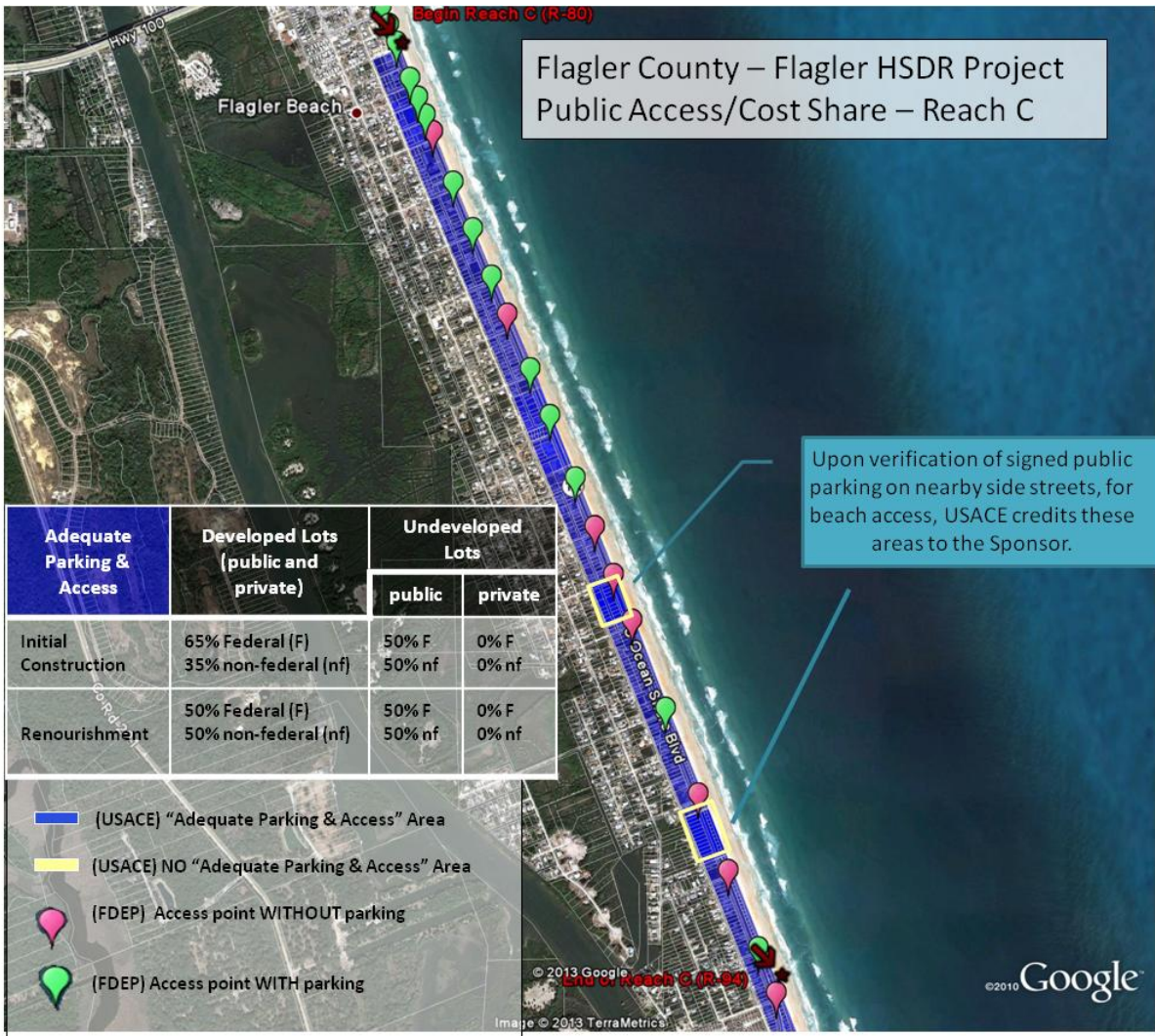
When the plans were evaluated against the four P&G accounts (the FDOT reactive plan to coastal storms by continuing rock revetment repairs and Corps proactive plan to

construct a beach dune system) the more complete plan is the beach dune system being proposed as the recommended plan. The plan provides a more complete solution and is in the federal interest to cost share at the historic rate.

ER 1165-2-130, paragraph 6.h. states, “Unless the protection of privately-owned beaches is incidental to protection of public beaches, they must be open to all visitors regardless of origin or home area, or provide protection to nearby public property to be eligible for Federal assistance.” Reach A is considered a privately-owned beach since it does not have significant public access, and its protection is not incidental to protection of Reach C. **Figure 5-13** and **Figure 5-14** display parking and access currently provided in Reaches A and C. As shown in **Figure 5-13**, a large portion of Reach A does not have adequate parking and access.



**Figure 5-13: Parking and access in Reach A. Access points noted by Florida Department of Environmental Protection (FDEP) and verified by field visits.**



**Figure 5-14: Parking and access in Reach C. Access points noted by Florida Department of Environmental Protection (FDEP) and verified by field visits.**

**Figure 5-14** shows that the majority of Reach C has adequate parking and access. Two areas have adequate street-side parking but lack a sign indicating that public parking is available. The sponsor has indicated that signage will be posted in order to claim 100% public access and parking coverage in Reach C. **Table 5-10** provides additional detail on public parking and access within the Recommended Plan area. There are at least 223 public parking spaces in the vicinity of Reach C. This amount of parking spaces is adequate to meet the beach use demand in the area and meets the policy requirements of ER 1165-2-130 which states “Generally, parking on free or reasonable terms should be available within a reasonable walking distance of the beach. The amount of parking should be consistent with the attendance used in benefit evaluation.”

**Table 5-10: Reach C Access and Parking**

Reach C Access and Parking				
Access Point	Within 1/2 Mile of Adjacent Access Point?	Public Parking Available?	Number of Parking Spaces	Notes
FLAGLER BEACH PIER	Y	Y	40	
4th St. S	Y	Y	25	
5th St. S	Y	Y	25	
6th St. S	Y	Y	70*	
	Y	Y	20	
7th St. S	Y	Y	20	
9th St. S	Y	Y	10	
10th St. S	Y	Y	10	
11th St. S	Y	Y	5	
12th St. S	Y		0	Within 1/4 mile of public parking available at both 11th and 13th Streets
13th St. S	Y	Y	5	
14th St. S	Y	Y	5	
15th St. S	Y	Y	10	
16th St. S	Y		0	Within 1/4 mile of public parking available at both 15th and 17th Streets
17th St. S	Y	Y	5	
18th St. S	Y	Y	10	
19th St. S	Y	Y	5	
20th St. S	Y		0	Within 1/4 mile of public parking available at 19th St.
21st St. S	Y		8	Unsigned street-side parking exists on west side of SR A1A. Sponsor has indicated that signs will be posted indicating that public parking is available.
22nd St. S	Y		0	Within 1/4 mile of public parking available at 23rd St.
23rd St. S	Y	Y	2	
25th St. S	Y		3	Within 1/4 mile of public parking available at 23rd St. Unsigned street-side parking exists on west side of SR A1A. Sponsor has indicated that signs will be posted indicating that public parking is available.
26th St. S	Y		10	Within 1/4 mile of public parking available at 27th St. Unsigned street-side parking exists on west side of SR A1A. Sponsor has indicated that signs will be posted indicating that public parking is available.
27th St. S	Y	Y	5	
28th St. S	Y		0	
Total			223	
*6th St. S Parking Area West of A1A				

The access points in **Table 5-9** are sourced from the FDEP's Public Access Guide (available online), which also provides the number of parking spaces available at each of these points. However, the number of parking spaces shown in the table reflect the results of a USACE site visit in 2011. The number of spaces estimated by USACE personnel in the vicinity of the pier south to 7<sup>th</sup> Street South was greater than the number on the FDEP database, and as such the values shown in the table for these access points were increased accordingly. For example, FDEP appears to have omitted the parking area at 6<sup>th</sup> Street South, which is estimated by USACE to contain 70 spaces. The values shown for 9<sup>th</sup> Street South to 28<sup>th</sup> Street South are unchanged from the FDEP database. See **Figure 5-15**.

Discussions with the sponsor indicated that public access and parking could not be provided in Reach A, and therefore no Federal interest in this reach. Additionally, the sponsor was not interested in providing access and parking in Reach A or pursuing **Reach AC duneH** as a Locally Preferred Plan (LPP). **Due to these facts, Reach C duneH is selected as the NED and Recommended Plan.**

The sponsor is aware of the parking and access requirements, including those listed in ER 1165-2-130 and ER 1105-2-100, and has committed to those requirements being met prior to any execution of a project partnership agreement (PPA).





**Figure 5-15: Parking and access for Recommended Plan (Reach C)**

### 5.3.6 Description of the NED Plan

As described above, the NED plan consists of a 10-foot dune and beach profile extension in Reach C only. **Figure 5-16** shows the location of the NED plan in Reach C relative to the entire study area. **Table 5-11** provides a summary of the plan.



Figure 5-16: Location of the NED Plan (Reach C)

**Table 5-11: Detailed Description of the NED Plan (FY11 price levels and discount rate).**

Name	Reach C duneH
Description	10' dune extension (note: the construction template will include a 10' sacrificial berm) constructed with a hydraulic dredge in Reach C
Shoreline Length	2.6 miles
Average # of Nourishment Events	5
Average Renourishment Interval	11 years
FDEP Monuments	R80 – R94
Average Volume of each nourishment event (cubic yards)	320,000
Total Volume over life of project (cubic yards)	1,610,000
Average Annual Cost	\$810,000
Average Annual Benefits	\$2,190,000

It should be noted that Beach-*fx* is a life-cycle simulation model. These results are based on 100 iterations of 50-year simulations. Each iteration within the simulation is unique. The values presented in the table above are an average of all 100 iterations. More information regarding renourishment volume and interval is provided in **Section 6.2.5** and **Appendix A**.

#### 5.3.6.1 Performance of the NED Plan in the Sea Level Rise (SLR) scenarios

An important question about the Recommended Plan is its performance under different Sea-Level Rise (SLR) scenarios. Each of the three SLR scenarios is considered equally likely to occur. Therefore, if the project does not perform under each scenario, then it cannot be considered a completely effective and adaptable plan. **Table 5-12** shows the BCRs and net benefits of the plan in the different SLR scenarios.

**Table 5-12: AAEQ Benefits and Costs for NED Plan in different SLR scenarios**

SLR Scenario	Benefits	Cost	Net Benefits	BCR
Baseline (SLR1)	\$2,190,000	\$810,000	\$1,387,000	<b>2.72</b>
Intermediate (SLR2)	\$3,475,000	\$1,155,000	\$2,320,000	<b>3.01</b>
High (SLR3)	\$4,625,000	\$1,581,000	\$3,044,000	<b>2.93</b>

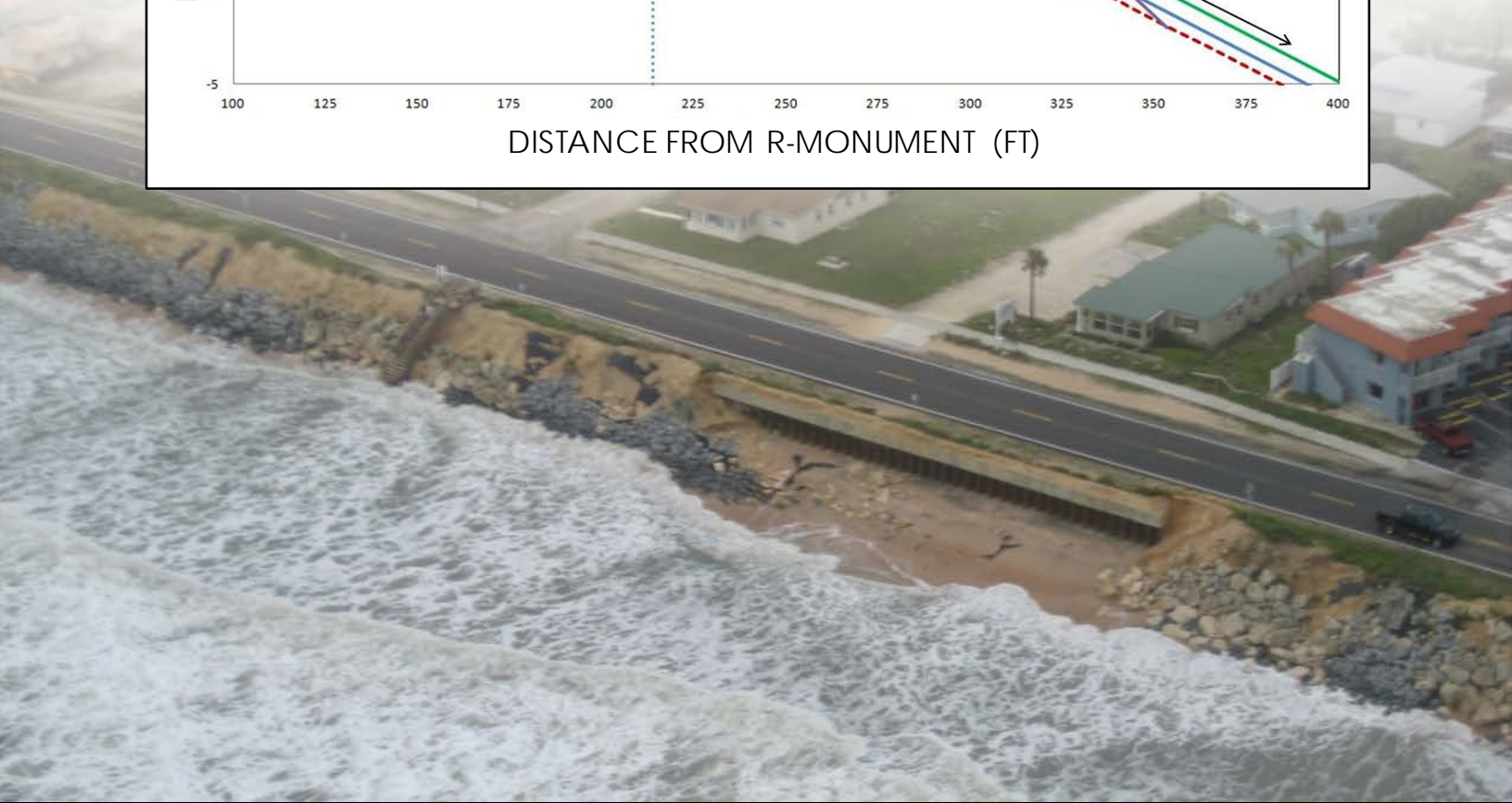
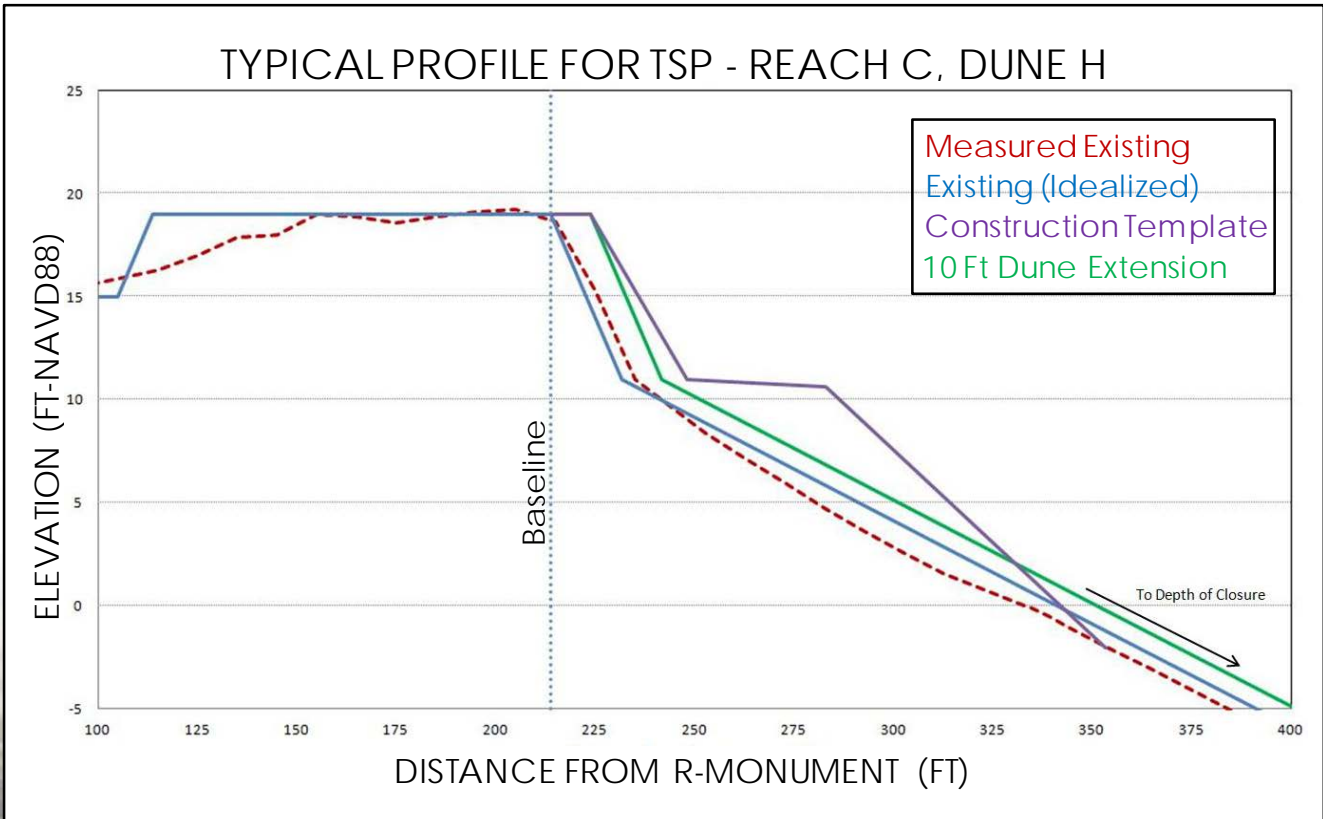
As shown in **Table 5-12**, though the benefits of the project increase significantly in the SLR scenarios, the costs also increase. Thus, the project performance (in terms of the benefit-cost ratio) is relatively constant throughout the SLR scenarios. As both costs

and benefits are increasing, the net benefits actually increase with increasing rates of sea-level rise. Overall, these results suggest that the NED Plan is both effective and robust in all three simulated SLR scenarios.

During the screening of the final array of alternatives, including berm alternatives, all three SLR scenarios were run and compared. In each scenario, no other alternative, including berm alternatives, gain enough benefits to become the NED plan.

# CHAPTER 6

## RECOMMENDED PLAN



FLAGLER COUNTY, FLORIDA  
HURRICANE AND STORM DAMAGE REDUCTION PROJECT  
FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

**CHAPTER 6**  
**THE RECOMMENDED PLAN**

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## 6 THE RECOMMENDED PLAN

### 6.1 Description of the Recommended Plan

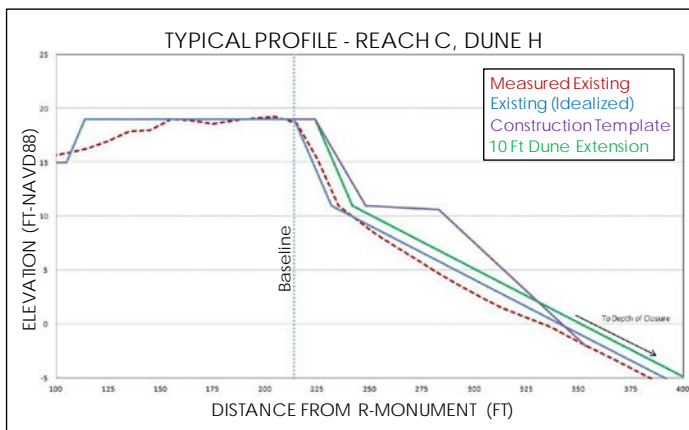
The NED plan consists of a 10-foot seaward extension of the existing dune. Construction of the dune extension will extend the existing berm and entire active beach profile seaward. **Table 6-1** provides a summary of the plan. There is no mitigation expected to be necessary for the Recommended Plan.

**Table 6- 1: Detailed Description of the NED Plan**



#### DESCRIPTION

- 10-foot seaward extension of the existing dune and beach profile in Reach C
- R-80 to R-94 plus tapers
- 2.6 miles of shoreline



#### NOURISHMENTS

Average # of Nourishment Events	5
Average Renourishment Interval	11 years
Average Volume (each event)	320,000 cu yards
Total Volume (over project life)	1,610,000 cu yards
Average Annual Cost *	\$ 1,239,000
Average Annual Benefits *	\$2,362,000
*FY14 price levels and discount rate	

It should be noted that Beach-*fx* is a life-cycle simulation model. These results are based on 100 iterations of simulations. Each iteration within the simulation is unique. The values presented in the above table are an average of all 100 iterations. More information regarding renourishment volume and interval is provided in **Section 6.2.5** and the **Engineering Appendix A**.

### 6.1.1 Benefits of the NED Plan

With **Alternative AC-Dune-H** screened out, the plan with the highest net benefits is **C-Dune-H**. Therefore, it is both the NED Plan and the Recommended Plan. This is also the plan with the highest Benefit to Cost Ratio. For the results presented from this point forward, the structure inventory value was inflated from FY2011 to FY2014 price levels to match the current project cost, which has also been refined to a higher level of detail. Benefits and costs have been discounted using the FY2014 Federal Water Resources Discount Rate of 3.5%. Therefore the costs and benefits will not match those presented in previous chapters.

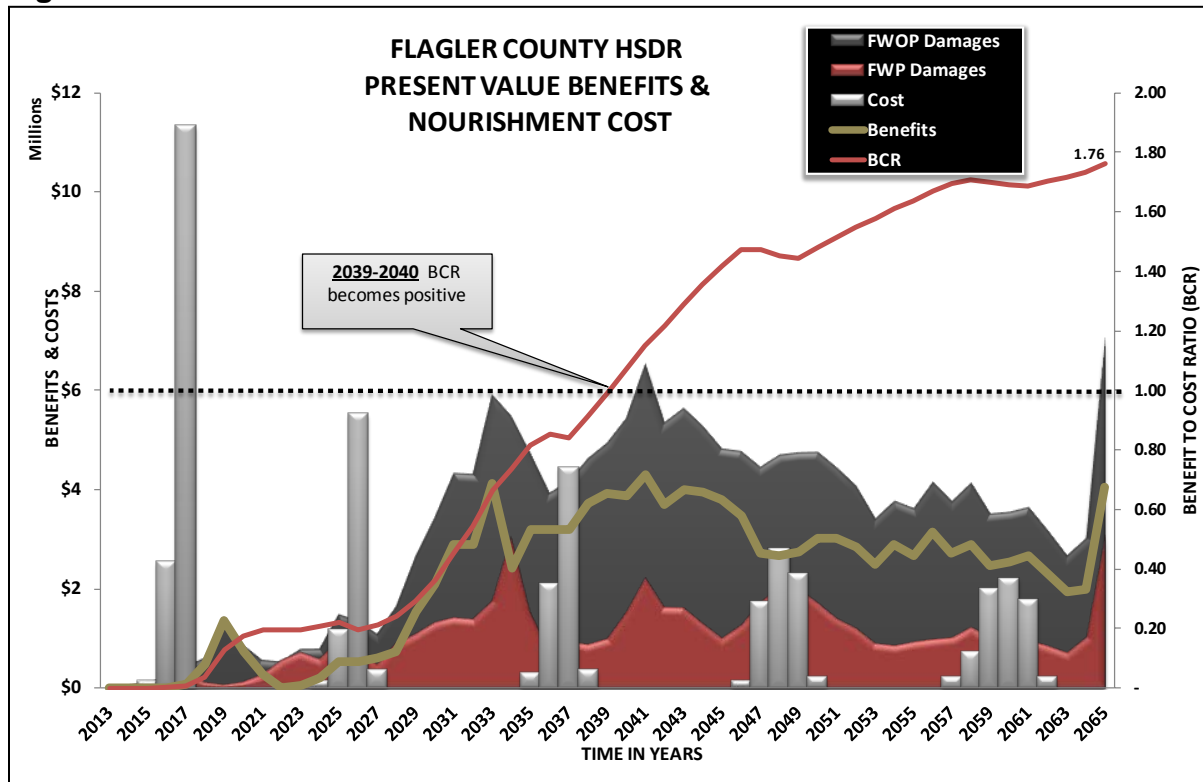
**Table 6- 2: Present Value (PV) of Damages in Reach C**

Number	Reach	FWOP DAMAGES	FWP DAMAGES	PV BENEFITS	% DAMAGE PREVENTED
32	RC-1	\$1,892,833	\$797	\$1,892,036	99.96%
33	RC-2	\$844,935	\$1,696	\$843,238	99.80%
34	RC-3	\$279,511	\$136	\$279,375	99.95%
35	RC-4	\$4,295,755	\$21,396	\$4,274,359	99.50%
36	RC-5	\$3,325,934	\$7,756	\$3,318,178	99.77%
37	RC-6	\$5,602,065	\$17,524	\$5,584,541	99.69%
38	RC-7	\$4,300,370	\$54,285	\$4,246,085	98.74%
39	RC-8	\$4,147,648	\$18,267	\$4,129,382	99.56%
40	RC-9	\$4,352,709	\$34,789	\$4,317,920	99.20%
41	RC-10	\$6,499,679	\$265,187	\$6,234,492	95.92%
42	RC-11	\$6,153,999	\$1,061,579	\$5,092,420	82.75%
43	RC-12	\$3,156,661	\$547,802	\$2,608,858	82.65%
44	RC-13	\$1,301,232	\$60,917	\$1,240,315	95.32%
45	RC-14	\$2,791,150	\$124,614	\$2,666,536	95.54%
	<b>Total</b>	<b>\$48,944,481</b>	<b>\$2,216,746</b>	<b>\$46,727,735</b>	<b>95.47%</b>

Most of the benefits are associated with reductions to armor damage along the State Road A1A (SR A1A) revetment. In the with-project condition, the cost of maintaining and repairing the revetment is significantly less than it would be in the without-project (FWOP) condition. This reduction is the primary source of economic benefits. As seen in **Table 6- 2**, the alternative is highly effective; it prevents 95% of total damages in Reach C. Notably, the total cost of maintaining the SR A1A revetment decreases from \$49 million in the FWOP condition to \$2.2 million in the with project condition. This is a 95% decrease. Within Reach C there are 272 single family structures, 35 multi-family structures, and 39 commercial structures located landward of SR A1A. The structures would be vulnerable to damage if SR A1A was not armored.

The economic benefits of the plan are generated by reductions in erosion damages. Inundation and wave attack damages were extremely limited in the study area. Model results suggest that the NED plan is highly effective at reducing erosion damages. In the with-project condition the vast majority of damages in Reach C are prevented. It can be seen that the damages modeled in Reach C during the first 10 years of the simulation (2013-2023) are within the modeling tolerance of the actual costs incurred by FDOT for maintaining the road from 2000-2010. It is after 2027 (in the model) that without-project damages start to increase dramatically. Only after the cumulative effects of storms, sea-level rise (SLR), and erosion over time begin to take their toll does the model begin to show significant damage. **Figure 6-1** provides detail on the accumulation of damages, benefits, and costs over time.

**Figure 6- 1: Present Value Benefits and Nourishment Cost.**



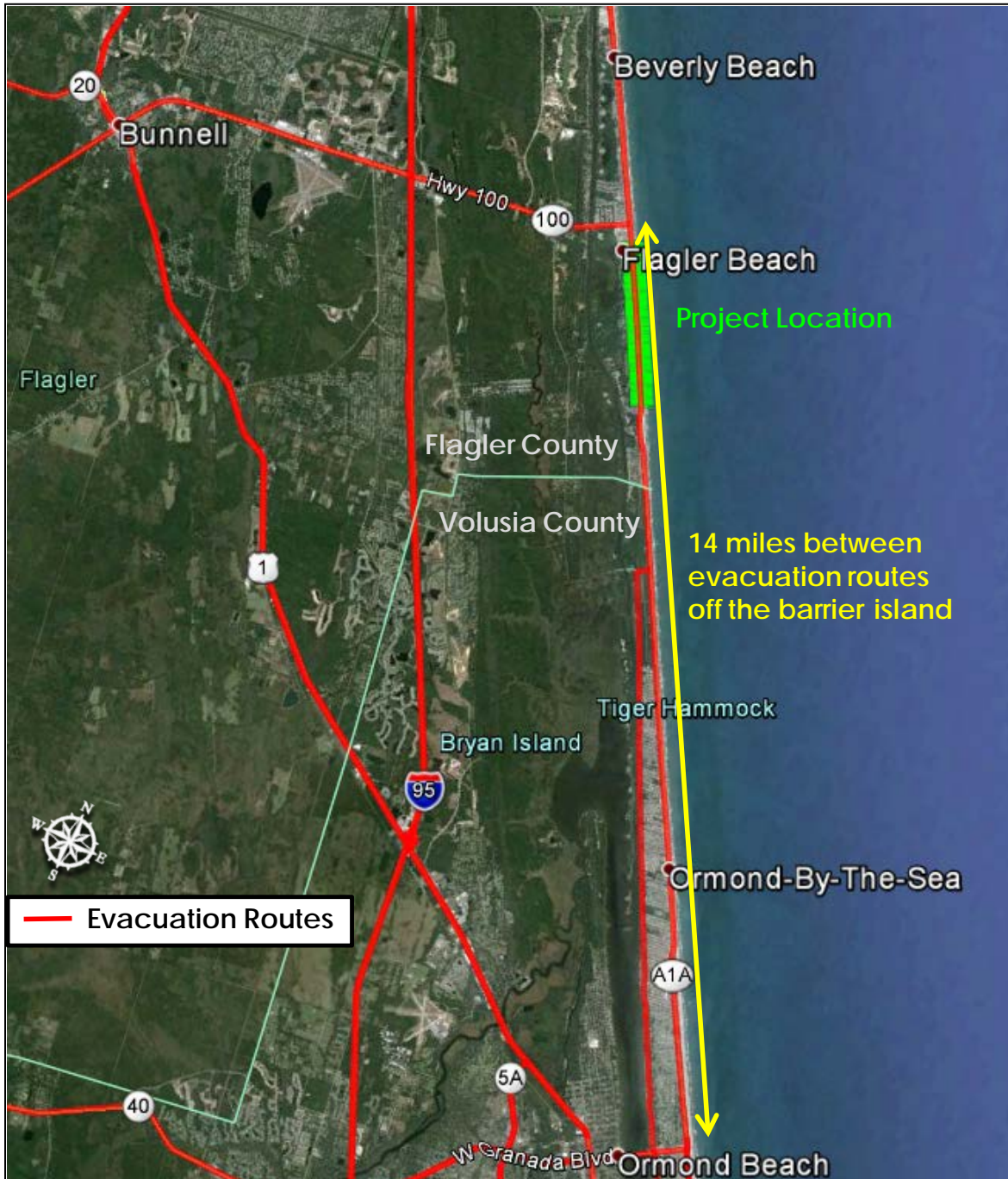
After the NED Plan was selected, traffic rerouting benefits were calculated using vehicle operating costs and average daily traffic counts. These benefits account for the reduction in time that the road would need to be closed for emergency road repairs. The average annual benefits for traffic rerouting are estimated at \$131,000. More information about the traffic rerouting analysis is available in **Addendum B of Economic Appendix C**.

Incidental recreation benefits were calculated using the Unit Day Value (UDV) method, as described in EGM 09-03 and in Appendix E of ER 1105-2-100. Using this method, the total present value of recreation benefits was estimated to be \$1,696,452 or \$72,326 in average annual terms. More information about the recreation analysis is available in the **Economic Appendix**.

It should be noted that the Recommended Plan is both highly effective and efficient. As the plan successfully reduces the vast majority of damages, a larger project is not necessary. Finally, the plan can be considered robust in the sense that it is economically justified in all 100 iterations simulated by Beach-*fx*. More detail on these results is available in the **Economic Appendix**.

The recommended plan reduces damages to the most vulnerable section of SR A1A which is critical for emergency evacuation events as well as recovery efforts following natural disasters. The population of the area served by the portion of the

A1A evacuation route that the project would protect is about 2,300 people. Reducing damages to this section provides a critical link in a 14 mile stretch between Highway 100 in Flagler Beach and West Granada Boulevard in Ormond Beach, shown in **Figure 6-2** where there are no other east-west evacuation routes off of the barrier island.



**Figure 6- 2: Evacuation Routes in the Vicinity of the Recommended Plan.**

Highway 100 is located about 0.25 miles from the northern terminus of the project location. There is a small section of aging seawall (about 150' long) under the pier structure located about mid way between the project and SR100. A row of diagonally oriented public parking spaces and a shore parallel boardwalk are located seaward of A1A along this 0.25 mile stretch between the project and SR100, but no other armoring is present other than that under the pier. This stretch of shoreline has been historically stable. - The distance from the southern end of the project to the Volusia County line is slightly over 1 mile. A1A curves inland through the first half mile of this stretch. In the half mile north of the Volusia County line, where SR A1A runs along the top of the dune, there is no existing protection. SR A1A is designated as an evacuation route in both directions; however there is very little population at the north end of Volusia County that would be likely to use it.

In the future without-project conditions, the existing revetment along SR A1A will continue to be repaired by dumping rocks on an as needed basis as erosion continues to occur and additional rocks will be dumped within the FDOT right of way in areas that are currently unarmored as erosion encroaches on the road. These efforts will likely use rocks or other material brought in with a dump truck, and the road will need to temporarily be closed, with traffic routed to Central Avenue. The traffic rerouting analysis described in **Addendum B of Appendix C** was used to determine the reduction in the number of traffic impacts as a result of the recommended plan being implemented. Compared to the future without-project conditions, the extension of the dune and beach profile would reduce the number of traffic impact incidences from 281 to 151 incidences in the future with-project condition over 50 years. This is a 46% reduction in traffic re-routing incidences.

Within the 2.6 miles of shoreline covered by the recommended plan, 1.75 miles is currently armored by FDOT revetment or seawall and 0.85 miles does not have existing armor. In the future without-project conditions, existing FDOT armor will be maintained by dumping rocks on an as needed basis and additional rocks will be dumped within the FDOT right of way in unarmored areas so that the entire 2.6-mile stretch will be armored. With an armored shoreline it is expected that there would be minimal beach area for turtles and birds to use for nesting habitat. In the future with-project conditions, the extension of the dune and beach profile would establish at least a 10 foot width of suitable nesting habitat along the entire 2.6-mile length of shoreline, which is 3.15 acres over 50 years. Public recreation will not reduce the habitat value of the 3.15 acres established by the project. There is a local group that monitors the area beaches and marks nests with caution tape so that the general public recreating on the beach can avoid the nests.

## 6.2 Project Design

### 6.2.1 Project Length

The Recommended Plan design, **Reach C Dune H** covers approximately 2.6 miles of the study area extending from R-80 to R-94 with tapers extending approximately 100 feet north of R-80 and approximately 100 feet south of R-94.

### 6.2.2 Project Dune

Existing dune elevations in the project area are between 18 and 20 feet-NAVD88. Evaluation of the design alternatives has shown that the existing elevations, when combined with a berm and/or dune extension, provide sufficient protection. No additional elevation is included in the selected design plan. For Reach C, the dune elevation is 19 feet-NAVD88.

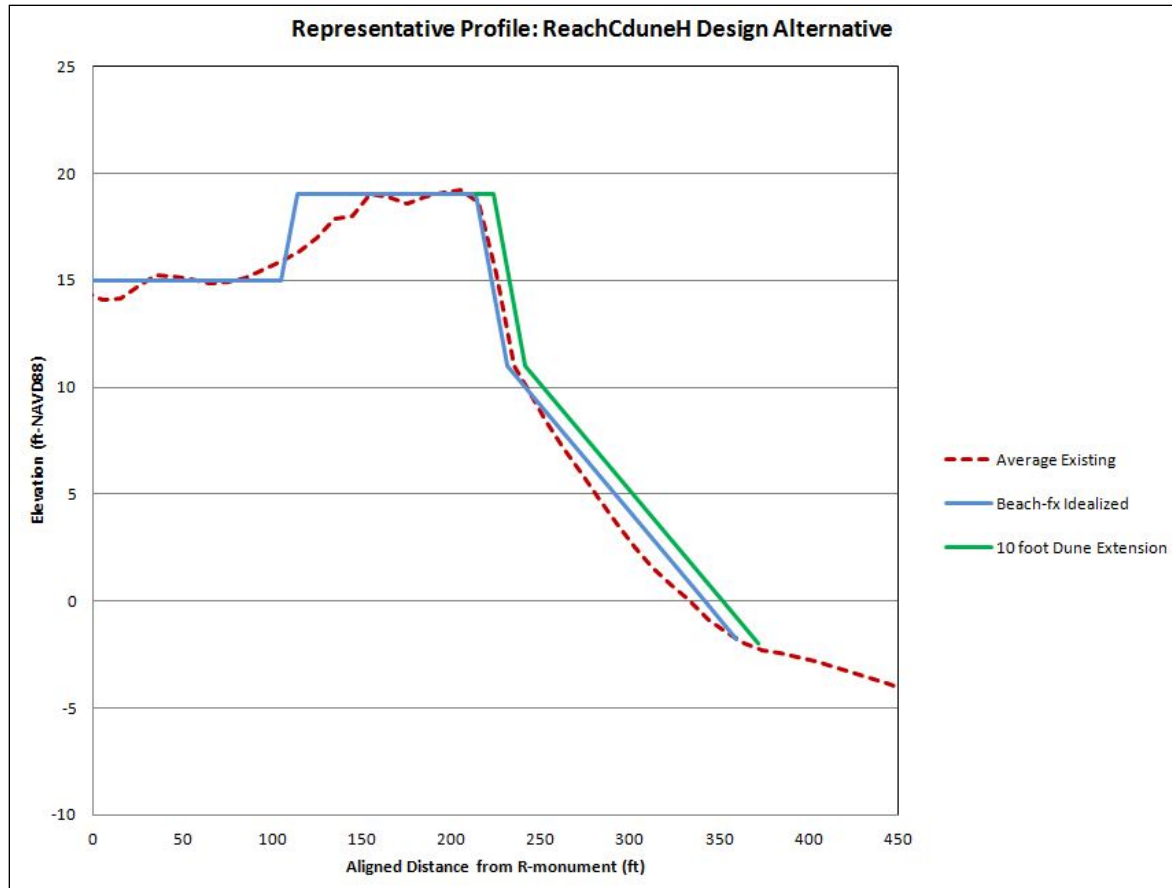
Existing dune widths in the project area are variable. Between R-80 and R-88, the dune has an average width of approximately 100 feet. Between R-88 and R-94 the average width is approximately 40 feet. SR A1A, which runs parallel to the project shoreline, is located within the dune. Based on the average dune widths, design widths are 110 feet in the northern portion of Reach C and 50 feet in the southern portion.

### 6.2.3 Project Berm

The design berm elevation in Reach C is 11 feet-NAVD88, which approximates the natural berm elevation. Restricting the design berm elevation to the natural berm elevation minimizes scarping of the beachfill as it undergoes readjustment. Vertical scarps can hinder beach access by nesting sea turtles, and may also pose safety problems related to recreational beach use. Other reasons for mimicking the natural berm elevation are related to storm damage protection. A berm constructed at a lower elevation would increase the probability of overtopping by relatively frequent storms, thereby offering less protection to upland development and/or existing dunes. A higher berm elevation could result in problems related to backshore flooding due to excessive rainfall or wave overtopping. A higher berm may also be more susceptible to wind-induced erosion.

Although the design berm for **Reach C Dune H** is described as a 0 foot extension, construction of the dune extension will increase the existing berm. **Figure 6- 2** shows a graphical representation of the Recommended Plan profile as modeled by Beach-*fx*.





**Figure 6- 3: Graphical Representation of Reach C Dune Extension Alternative Beach-fx Profile**

#### 6.2.4 Project Beach Slopes

After initial placement of the sand, wave action will adjust and sort the material into an equilibrium beach slope, similar to the native beach. In Flagler County, the native beach slopes in Reach C are estimated as a 1 (vertical) on 2.2 (horizontal) at the dune, 1 on 10 from the berm to MLW (-3.1 feet-NAVD88), and 1 on 40 to 1 on 70 below MLW. The estimate of the slope of the material after adjustment is based on averaging the beach profile slopes of the native beach from the mean low water datum to the approximate location of the 12-foot depth contour. Below the 12-foot depth contour, various bar type features appear in the profiles, making a representative slope difficult to determine.

It is unnecessary and impractical to artificially grade beach slopes below the mean low water elevation since they will be shaped by wave action. For this reason, the front slope of the beach fill placed at the time of construction or future renourishment may differ from that of the natural profile. The angle of repose of the hydraulically placed material depends on the characteristics of the fill material and the wave

climate in the project area. With steep initial slopes, the material will quickly adjust to the natural slopes.

### 6.2.5 Project Volumes and Renourishment Interval

Traditionally, beach fill designs are presented as a set of three cross-sectional templates, the design template, which is based on an equilibrium profile translated seaward by the desired width of the berm or mean high water (MHW) extension; the advanced nourishment template, which represents the volume of material that is expected to erode between successive renourishment intervals; and the construction template, which includes both the design and advanced fill quantities, but incorporates the wider berm and steeper slope that reflects the capabilities of the construction equipment. The design template is the minimum beach profile to be maintained, while the advance nourishment template contains the volume of material that will dissipate through erosion over the economically optimized renourishment interval while protecting the design template. This traditional approach, however, does not conform well to the probabilistic nature of the Beach-*fx* model or the methodology used for determining renourishment requirements.

Beach-*fx* begins with the desired design template (i.e., the 10-foot dune and profile extension, **Figure 6- 2**). Each life-cycle simulation then applies randomly generated storms, storm erosion, and natural background shoreline change rates. At one-year intervals, the model evaluates the resulting shoreline against two criteria (1) whether shoreline position at one or more reaches has exceeded one or more planned nourishment triggers and (2) whether the total volume presently required to fill the original design template exceeds the mobilization threshold. If both criteria are met then a renourishment event is initiated. There are three planned nourishment triggers in Beach-*fx*: berm width, dune width, and dune height. Each trigger indicates what percentage of the design template berm width, dune width, or dune height must be present to *prevent* a renourishment (For example, a 90% [0.90] dune width trigger means that 90% of the total design template dune width (existing dune plus fill extension) must remain intact. If 10% or more of the template dune width is eroded, the first criteria for initiating a planned renourishment event has been met. Should the allowable erosion be exceeded in one or more Beach-*fx* design reaches, then Beach-*fx* computes the volume required (over all of the *triggered* nourishment Beach-*fx* design reaches) to fill the original design template and compares that volume to the mobilization threshold. The mobilization threshold is the optimal volume for a project that is both economical and maintains adequate storm damage protection at all times over the life of the project. If the mobilization threshold is exceeded a renourishment over all planned nourishment Beach-*fx* design reaches occurs and the model continues through the remainder of the life-cycle.

For the Recommended Plan, the berm width, dune width, and dune height planned nourishment triggers were set at 0, 0.91, and 0.9, respectively. The mobilization threshold was set to 300,000 cubic yards. Together, the triggers and the mobilization

threshold allow for the optimization of the beach fill based on the physical dimensions of the project, as well as assumptions regarding tolerable erosion limits and reasonable fill volumes. Sensitivity analysis of the nourishment triggers and mobilization threshold indicated that threshold volume was the dominant parameter for optimizing project cost for an alternative in which the berm width has a zero value. A mobilization threshold of 300,000 cubic yards was found to be (when combined with the above nourishment triggers), the most optimal threshold value. Decreasing the threshold decreased the net NED benefits. Increasing the threshold above 300,000 cubic yards produced a small increase in the net NED benefits. However, it also allowed segments of the dune to erode to beyond the existing project condition. This was not considered to be an acceptable assumption. The net benefits associated with the 300,000 and 400,000 cubic yard thresholds are \$26,803,584 and \$26,810,596 respectively. The sensitivity analysis used to determine 300,000 cubic yards as the optimal nourishment threshold is contained in **Appendix C**. This analysis optimizes the triggers used to determine when the renourishment should occur and not the resulting renourishment interval. The renourishment interval is the most likely interval to occur based on the triggers, as described in the following paragraphs.

Each complete Beach-*fx* model run consists of 100 iterations, each iteration representing the life of the project. Based on the Recommended Plan (100 iteration runs), a range of volumes was determined for the initial fill event and each subsequent renourishment event. Model runs were made for each of the three SLR cases: Base, Intermediate, and High. **Table 6-3** provides the minimum, maximum, and average fill volumes for both initial and renourishment events over the life of the project. This table also provides the number of expected renourishment events.

Traditionally, in Hurricane and Storm Damage Reduction (HSDR) studies, a fixed renourishment interval is defined and optimized for the life of the project. This interval is based in part on a clear distinction between a design berm and advance fill. With Beach-*fx*, no such distinction is defined. Rather, renourishment events are triggered within the model when specific criteria are met. In this case, the triggers were set up to simulate a point at which the dune and beach profile extension had eroded away and were no longer capable of reducing damages. Based on these parameters, the expected renourishment interval is 11 years, defined by the average time between renourishments triggered over 100 iterations of a 50-year life cycle simulated by Beach-*fx*. In reality, this interval could vary depending on the timing of erosion and storm events.

**Table 6-3: Project Volumes**

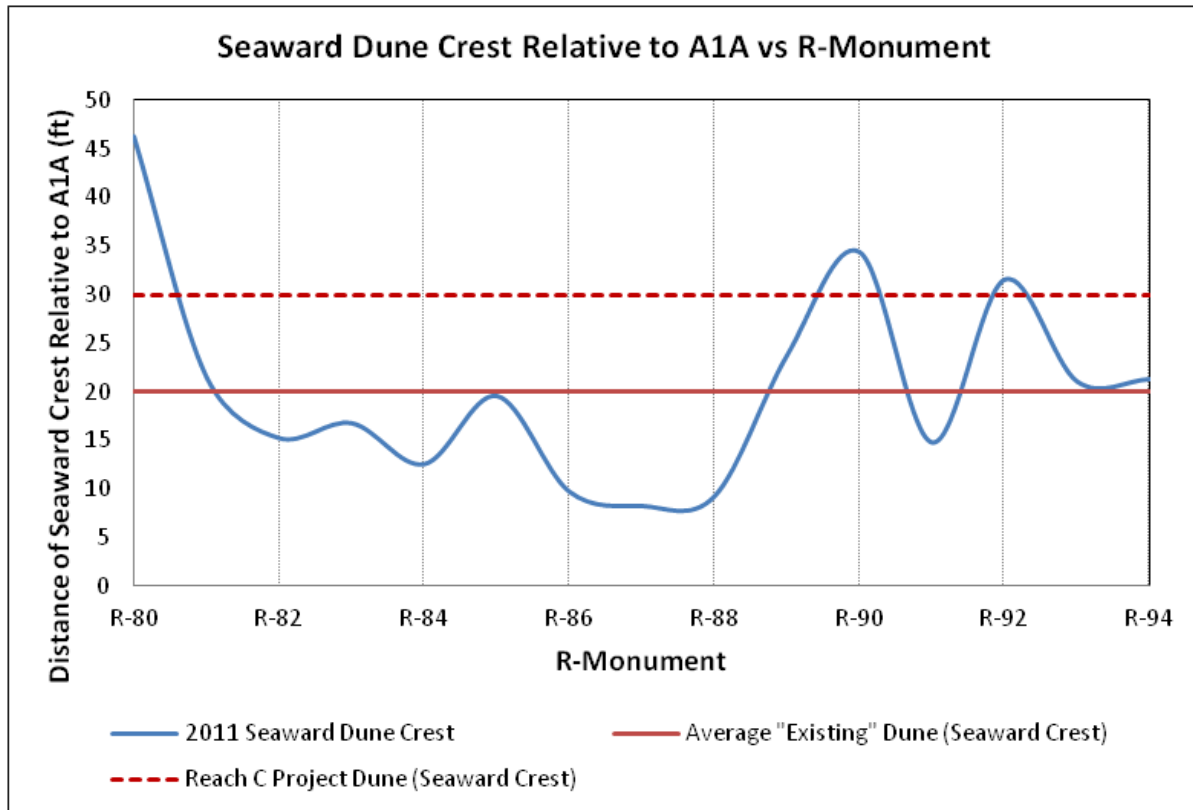
Project Volumes (Averaged over 100 Beach-fx Life-cycle Iterations)				
Sea Level Rise Case	Volume Description	Initial Fill Volume (cy)	No. of Renourishment Events* (not including initial construction)	Average Volume per Interval (cy)
Base	Min - Max	300,000 – 370,000	4	300,000 – 350,000
	Average	330,000		320,000
Intermediate	Min - Max	300,000 – 370,000	5	300,000 – 350,000
	Average	330,000		320,000
High	Min - Max	350,000 – 410,000	8	310,000 – 370,000
	Average	370,000		330,000
*Due to its probabilistic nature, Beach-fx can result in a range of required renourishment events. However, for the Flagler County Recommended Plan (a relatively modest extension of the dune and profile), the minimum and maximum number of events was the same.				

### 6.3 Project Construction

The Recommended Plan for Flagler County results in a 10-foot seaward extension of the existing dune and beach profile. Due to erosion, armor damage, and intermittent repairs and maintenance, the project shoreline does not presently have a smooth, consistent dune feature. In order to ensure that the nourishment project provides the maximum benefit, it is necessary to first establish a smooth, relatively straight base construction line that will allow the project to perform as predicted during the Beach-fx shoreline analysis.

In order to establish the project construction line, SR A1A, which runs roughly parallel to the project shoreline, was identified as a reliable land-based reference for developing a smooth, consistent project dune. The seaward crest of the dune was then identified as the shoreline profile reference point. Based on historical surveys, it was determined that the average distance between the eastern edge of SR A1A and the seaward crest of the dune (as measured at each FDEP R-monument) in Reach C is 20 feet. Therefore, the base construction line (defined as the “existing” seaward crest of the dune) is designated to be 20 feet east of, and parallel to, SR A1A. The project shoreline would then add an additional 10 feet of width to the base construction line (“existing” dune). Existing armor, such as stone revetment or seawall, located within this 10-foot extension will be buried under the constructed dune rather than removed. If the constructed dune extension is severely eroded

during a storm event or several storms where intermediate repairs cannot be made, the armor will act as an additional layer of protection to SR A1A. **Figure 6-3** shows graphically the location of the measured (2011 survey), “existing,” and project dunes relative to the eastern edge of SR A1A. Note that this approach will ultimately provide a consistent level of protection to the road, which is the primary damageable infrastructure.

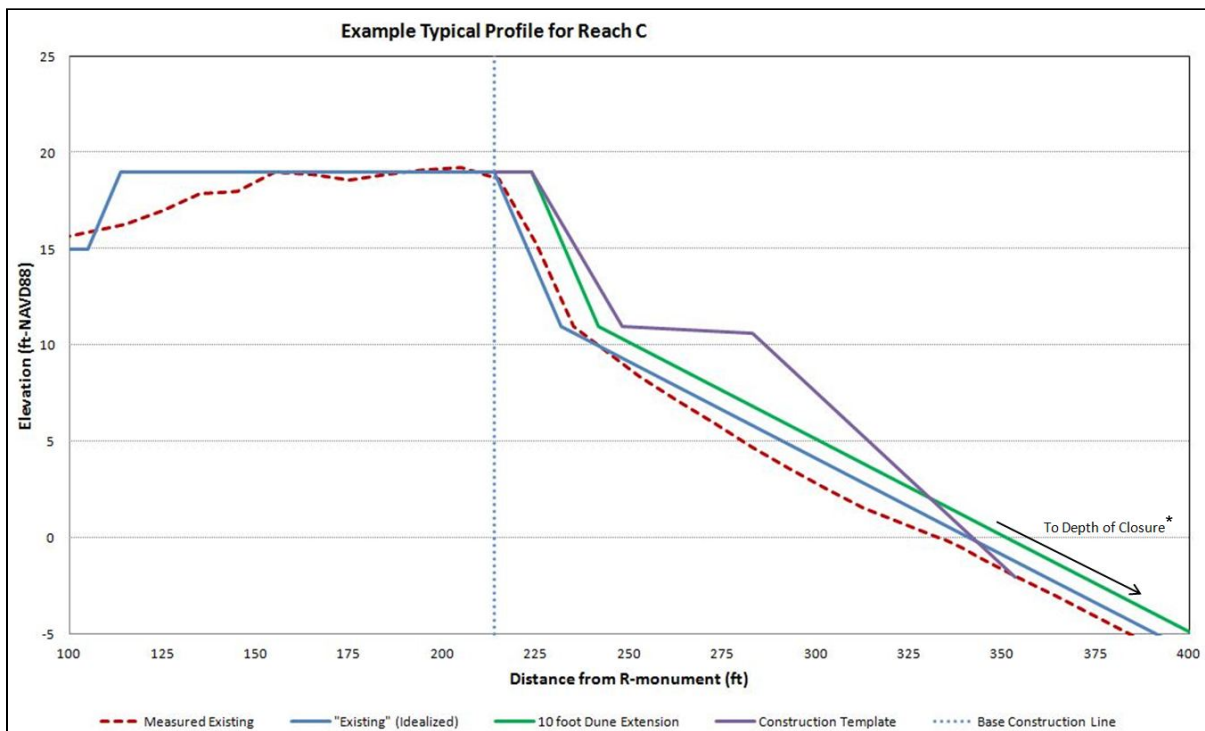


**Figure 6-4: Measured and Design Dune Locations Relative to State Road A1A**

Beach-*fx* estimates that initial construction of the Reach C 10-foot dune and beach profile extension will require between 300,000 and 370,000 cubic yards of material. Using the 2011 survey (the most recently available reference), the designated construction line, and the project (10-foot dune and beach profile extension) design template, it was determined that the volume required for initial construction would be approximately 360,000 cubic yards. While this is above the Beach-*fx* average initial volume of 330,000 cubic yards, it is within 10% of the modeled values and is considered reasonable. Therefore, this volume is considered to be appropriate verification of the location of the base construction line and the validity of the project template. Because this volume is based on a conceptual layout and survey information that will be updated prior to construction, it will be used only for verification of the design dimensions and will not be used for cost estimating. Costs will continue to be based on average Beach-*fx* volumes.

As previously discussed, the front slope of the beach fill placed at the time of construction or future renourishment may differ from that of the natural profile. This reflects the capabilities of the construction equipment that will be used to build the shore protection project. Within the first year or two after placement of the beach fill, the construction profile will be reshaped by waves into an equilibrium profile, causing the berm to retreat to a position more characteristic of the project design template.

Based on the estimated initial fill volume, constructability considerations, and existing (2011) shoreline dimensions, a construction template applicable to Reach C was determined. The construction template (shown in **Figure 6-4**) consists of a 10-foot wide dune extension with a 1 on 3 slope, a 35 foot berm with a 1 on 100 slope, and foreshore fill extending to approximately -2 feet-NAVD88 with a slope of 1 on 10. This template, dimensioned for constructability, will then equilibrate into the project (10-foot dune and beach profile extension) template. The volume of material in the equilibrated profile (between the template and the “existing” condition) represents the material that is expected to erode between successive nourishment events.



\*The depth of closure for a given or characteristic time interval is the most landward depth seaward of which there is no significant change in bottom elevation and no significant net sediment transport between the nearshore and the offshore.

**Figure 6-5: Typical Profile Sketch, Recommended Plan**

## 6.4 Renourishment Events

While the basic principles of renourishment still apply, due to the probabilistic nature of Beach-fx and the way in which the model assesses renourishment requirements, a new means of assessing project performance must be employed. The former concepts of “design template” and “advance fill” are no longer applicable in the traditional sense. As shown in **Figure 6-4** the entire 10-foot dune and beach profile extension template acts as the “advance fill”, while the existing beach profile is the minimum acceptable profile (making it akin to what was formerly the “design template”).

Assessing the performance of the project fill now has two stages. First, a survey of the project area (such as a monitoring or post-storm survey) will be assessed to determine if the seaward crest of the dune at any of the R-monument locations within the project have receded past the Base Construction Line (**Figure 6-4**). If recession has occurred at one or more of the R-monuments, then a summation of the volume required to restore those profiles to the original construction template will be made. If the total volume required to restore the receded profiles exceeds the threshold volume, then a renourishment event is recommended. It is possible that the decision to renourish may be influenced by the timing of Federal appropriations and available funding for the project.

## 6.5 Borrow Area

Borrow areas 2A, 2B, 2C, and 3A shown in **Figure 6-5** all contain compatible sand that could be used for construction of the Recommended Plan. Areas 2A and 2B, which are estimated to contain a combined volume of 3 million cubic yards (mcy), will be used since they are located closest to the placement area. These borrow areas are part of the Korona Ridge Field geomorphological unit and are located approximately 7 miles off-shore of Flagler Beach. Thicknesses of the beach compatible sand layers vary from 5 to 18 feet in Area 2. Conservative values between 5 and 7 feet below seafloor surface were used as dredging depths for the volume estimates shown in **Table 6-4**.

A total of 1,610,000 cy will be need for placement over the 50 years of the Recommended Plan. It is assumed that dredging losses will be 26% of the placement volume based on information from the Duval County Shore Protection Project which used methods similar to those anticipated to be used for this project, and had a borrow area a similar distance offshore. Therefore the estimated volume to be dredged from Areas 2A and 2B over the 50-year Recommended Plan is 2,028,600 mcy. More details on borrow area compatibility and characteristics can be found in **Appendix D**.

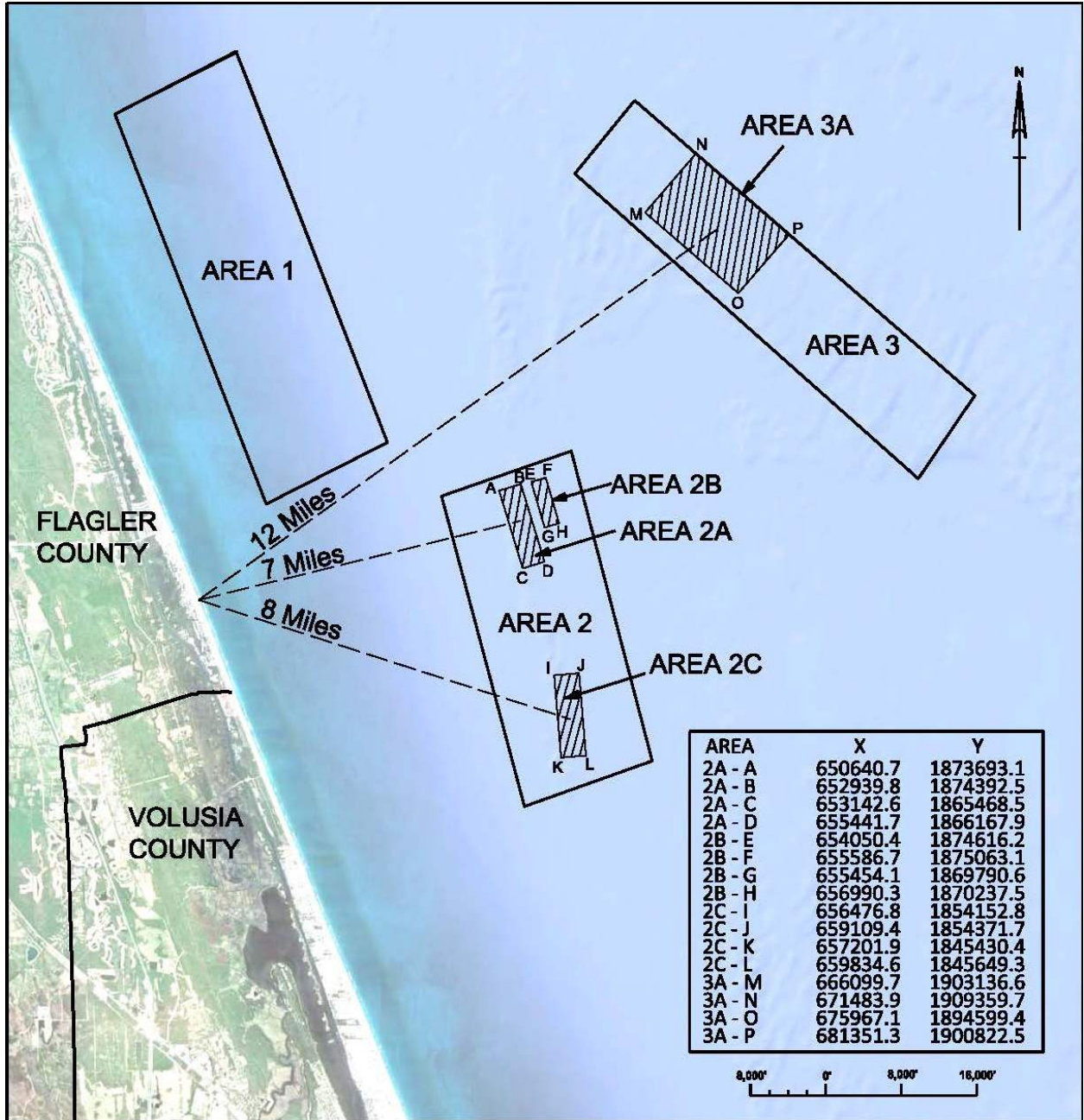


Figure 6-6: Borrow sub-areas 2A, 2B, and 2C

Table 6-4: Details for Proposed Borrow Area 2A, 2B, and 2C

Sub-area	Approximate Size	Approximate Volume	Borings
2A	5,000 ft x 1,700 ft	1.7 mcy	VC-FSP11-14, VC-FSP11-16
2B	3,300 ft x 1,500 ft	1.3 mcy	VC-FSP11-15
2C	7,000 ft x 2,000 ft	2.6 mcy	VC-FSP11-22



The borrow areas to be used are located within Outer Continental Shelf (OCS) waters. Under Section 8(k) of the Outer Continental Shelf Lands Act (OCSLA), dredging of sediment resources within the OCS requires authorization by the Bureau of Ocean Energy Management (BOEM) for use during initial or maintenance construction or both. The BOEM Leasing Division is charged with environmentally responsible management of Federal OCS sand and gravel resources. P.L. 102-426 [43 United States Code (U.S.C.) 1337(k)(2)], enacted October 31, 1994, gave BOEM the authority to negotiate, on a noncompetitive basis, the rights to OCS sand, gravel, and shell resources for Coastal Storm Damage Reduction (CSDR) projects; beach or wetlands restoration projects; or for use in construction projects funded in whole or part by or authorized by the Federal government. Recognizing that identified borrow areas are within the OCS, BOEM has agreed to serve as a cooperating Federal agency on this study and may undertake a connected action (i.e., authorize use of the OCS borrow area) that is related to, but unique from the USACE proposed action. BOEM's proposed action is to issue a negotiated agreement pursuant to its authority under the OCSLA.

A tri-party agreement for use of the borrow area in OCS waters between BOEM, USACE, and Flagler County will be executed during the PED phase, prior to construction. BOEM has been engaged throughout the study process as a cooperating agency on this project, and currently there are no issues that would prevent the use of the proposed borrow areas for this project.

## 6.6 Project Monitoring

Physical monitoring of the recommended project is necessary to assess project performance and to ensure that project functionality is maintained throughout the 50-year project life. The monitoring plan will be directed primarily toward accomplishing systematic measurements of the beach profile shape. Profile surveys should provide accurate assessments of dune and beach fill volumes and a basis for assessing post-construction dune and beach fill adjustments, as well as variation in the profile shape due to seasonal changes and storms. Monitoring will play a vital role in determining if project renourishment is necessary. Post-construction monitoring activities include topographic and bathymetric surveys of the placement area on an annual basis for 3 years following construction and then biannually until the next construction event. The cost for this post-construction monitoring is included in the cost-shared total project cost. This cost-shared post construction monitoring is separate from the monitoring described in **Section 6.10**.

Other monitoring efforts include bathymetric mapping of the borrow site, which will be done as part of the pre-construction engineering and design (PED) phase prior to each nourishment.

Measured wind, wave, and water-level information will be obtained from the best available existing data sources. This data will be applied in support of previously

discussed monitoring efforts. It will also be used to periodically assess the state of sea-level rise (SLR) and to determine if reassessment of the project volumes and/or renourishment intervals based on an intermediate high SLR case is required.

### 6.7 Detailed Cost Estimates (MCACES)

The (Micro-Computer Aided Cost Estimating System) MCACES for the NED plan reflects FY14 (1 Oct 13) price levels. A detailed cost estimate for the Recommended Plan is included in **Appendix B (Cost Engineering and Risk Analysis)**.

### 6.8 Design and Construction Considerations

During the PED phase, new surveys will be conducted and a determination made regarding the erosion or accretion of the shoreline, and a final initial fill volume will be determined prior to construction.

The major items of construction work, in sequence, include dredging material (sand) from the offshore borrow areas 2A and 2B, located approximately 7 miles offshore of the project site (**Figure 6-5** and **Table 6-5**), placement by hydraulic dredge in the project area, then planting of vegetation on the constructed dune. Vegetation will be planted on areas of the existing dune disturbed by construction, as well as newly constructed areas to stabilize the fill. It is assumed that dune planting will only be necessary for initial construction and that vegetation will spread and naturally grow and spread to any areas that are renourished in the future.

Currently, there are no calendar restrictions on dredging and or placement activities. The duration of initial construction is estimated to be 30 days for mob/demob and 123 days for construction. The duration of subsequent periodic nourishments is estimated to be 30 days for mob/demob and 41 days for construction.

### 6.9 Lands, Easements, Rights-of-Way, Relocations, Disposal (LERRD) Considerations

In accordance with the “Interagency Coordination Agreement for Civil Works Projects between Florida Department of Environmental Protection (FDEP) and the United States Army Corps of Engineers Jacksonville District (USACE SAJ)” dated February 2006, the non-federal sponsor will obtain all real estate permissions required from the State of Florida to place material on state-owned submerged lands in accordance with the beach nourishment plans submitted with the application for an erosion control line. This will include the use of any submerged borrow areas and/or pipeline corridors in state public trust waters.

Perpetual Storm Damage Reduction easements will be required over approximately 2.6 miles of Atlantic shoreline in Flagler County from FDEP monument R-80 to R-94 located landward of the proposed ECL. A perpetual beach storm damage reduction easement will be required over 184 parcels that exist between the FDOT right of way and the ocean. 172 of these parcels are privately owned and 12 parcels are public. The Flagler Beach pier, located at R-79, is approximately 800-feet beyond the northern limit of the R-80 taper and is therefore outside of the project limits.

The Reach C project length (R-80 to R-94) contains 42 dune walkovers. Walkovers include 21 privately-owned and 21 local government-owned structures. Walkovers on public properties are considered relocations, and one-time replacement costs of the 21 public structures is included in the total project cost, should these structures need to be removed in order to construct the project. Replacement of privately-owned structures will not be included in project costs.

The borrow area is located approximately 7 miles offshore northeast of the project area. As the borrow area is located within the territorial waters of the United States, the Corps of Engineers will enter into a Memorandum of Agreement (MOA) with the Bureau of Ocean Energy Management (BOEM) pursuant to 43 U.S.C. Section 1337(k)(2).

Staging areas have not been identified at this time, but will require a temporary work area easement if not located within the perpetual storm damage reduction easement area. Additional information can be found in the **Real Estate Appendix**.

## 6.10 Operations and Maintenance Considerations

### 6.10.1 Beach Nourishment

By Public Law 84-826 dated 1956 (beach nourishment), periodic nourishment is considered construction and not maintenance, and therefore is cost shared. The Recommended Plan involves initial construction and periodic nourishment of a dune and beach profile extension, and is technically “beach nourishment.” The operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) anticipated for this project includes semiannual beach profile surveys, aerial photography, and an annual monitoring report. Other OMRR&R items may include revegetating the dune and beach tilling although it is not anticipated that these actions will be needed for this project. The operations and maintenance will also include the draft items of local cooperation described in **Section 9.1**. These items entail publicizing floodplain information, ensuring continued conditions of public ownership and use of the shore, performing surveillance of the beach, and any specific directions prescribed by the government. Based on the size and scope of the recommended plan and the cost of similar activities for similar projects, the annual costs for OMRR&R, including beachfill monitoring over the 50 year project, are estimated to be \$10,000 per year.

Operations and maintenance is borne 100% by the non-federal sponsor and is detailed in the Project Partnership Agreement (PPA). An Operations and Maintenance Manual will be completed by USACE and provided to the sponsor following completion of initial construction.

## 6.11 Summary of Accounts

The Recommended Plan was shown to have a net improvement over the future without- project condition and has positive net benefits. The Recommended Plan is the NED plan.

In addition to being the NED plan and meeting the Federal objective to contribute to national economic development, the Recommended Plan is also consistent with the Environmental Operating Principles because it is a sustainable plan that has taken environmental issues into consideration. The Recommended Plan is also consistent with the state and local objectives described in **section 4.3**. The Recommended Plan is consistent with the planning constraint described in **section 4.4.1**, to avoid conflict with Federal and state regulations.

The Recommended Plan meets all four of the planning objectives listed in **Section 4.7**. The Recommended Plan maximizes NED benefits by reducing storm damages, and provides incidental environmental and recreational benefits. The Recommended Plan will benefit the Environmental Quality (EQ) account by improving the environmental quality in the project area. **Table 7-1** shows that the Recommended Plan will have positive impacts on several environmental factors compared to the no-action alternative. These positive environmental impacts include improved dune habitat and increased sea turtle nesting area. The Recommended Plan would also benefit the Regional Economic Development (RED) and Other Social Effects (OSE) accounts by maintaining opportunities for recreational use of beach and nearshore areas. **Table 7-1** shows that the Recommended Plan would provide positive long-term benefits for improving the aesthetics of the beach and maintaining use of the beach for recreational interests, while the aesthetics and beach availability for recreation would likely decline in the long term with the no-action alternative. SR A1A is recognized as a national scenic byway. The Recommended Plan provides protection for SR A1A which is a hurricane evacuation route and will improve the communities' resiliency in post-storm recovery situations.

## 6.12 Risk and Uncertainty

### 6.12.1 Residual Risks

The proposed project would greatly reduce, but not completely eliminate future storm damages. Coastal storm damages are reduced by approximately 96 percent

in the location of the recommended plan (design reach C) over the 50 year period of analysis; therefore, the residual damages would be 4 percent in this area. Across all four design reaches evaluated (design reaches A, B, C, and D), the recommended plan reduces approximately 65% of coastal storm damages over the 50 year period of analysis; therefore the residual damages across the four design reaches is 35%. The greatest residual risk remains in design reach A, where justifiable improvements could be made if public access was made available. In Reach A the present value FWOP damages are \$14,527,576 over 50 years. The majority of these damages are associated with the economic cost of older houses (built prior to 1988) constructing vinyl sheet pile walls to protect residences. Flagler County will continue to take steps to mitigate this residual risk through Florida's Coastal Construction Control Line (CCCL) program. Under this program any new development must be built back from the dune and on pilings. The FWOP damages in design reach A do not include damages to SR A1A which is located landward of the residences in this reach. The residual risk that remains in design reaches B and D consists of minor armor costs and road damage to SR A1A which is not great enough to justify a project.

The project is designed to reduce damages from storm waves, direct flooding, and erosion, but would not prevent any damage from back bay flooding; therefore, any ground-level floors of structures, ground-level floor contents, vehicles, landscaping, and property stored outdoors on the ground would still be subject to saltwater flooding that flows in from the Intracoastal Waterway on the west side of the barrier island. However, back-bay flooding is a relatively minor issue in the study area extending 400 feet inland from the Mean High Water (MHW) line. This is where the benefits of the project are being measured and any potential damages associated with back bay flooding were not claimed as a project benefit. The project is not claiming any benefits beyond 400 feet inland from the Mean High Water (MHW) line, damages to structures past this extent were not calculated. Structures would also continue to be subject to damage from hurricane winds and windblown debris. Even new construction is not immune to damage, especially from these processes.

The proposed dune and beach profile extension would reduce damages but does not have a specific design level. In other words, the project is not designed to fully withstand a certain category of hurricane or a certain frequency storm event. The project purpose is storm damage reduction, and the dune and profile extension is not designed to prevent loss of life. Loss of life is prevented by the existing procedures of evacuating the barrier island completely, well before expected hurricane landfall and removing the residents from harm's way. The erratic nature and unpredictability of hurricane path and intensity require early and safe evacuation. That policy should be continued either with or without the storm damage reduction project.

The Florida Hazard Mitigation Strategy is a statewide initiative, under the direction of the Department of Community Affairs, to foster the development of a Local Mitigation Strategy (LMS) in each of Florida's 67 counties. Flagler County was one of the first

counties in the state and among the first counties nationwide to adopt a working LMS. The Flagler County LMS was last updated and approved by the Federal Emergency Management Agency (FEMA) in 2011. The LMS is a long term effort that is updated as needed to reduce the County's vulnerability to disasters and minimize damage.

The Flagler County Emergency Management Division provides coordination of resources and decision making during disasters. Emergency Management assists with the coordination of preparedness programs for all citizens of Flagler County, County agencies, and support organizations. The Division develops and maintains emergency plans for all types of natural and man-made hazards, which include hurricane evacuation plans, and provides analysis and recommendations necessary to make decisions that will effectively save lives and protect property in such emergencies.

Public safety risks can be reduced by actions taken at the local, state, and Federal levels. **Table 6-5** describes the actions that can be taken by the entities associated with this project to improve public safety, as well as the limitations of their actions. The greatest level of public safety is achieved when action is taken at the local, state, and Federal Level to reduce public safety risks in a comprehensive manner.

**Table 6-5: Roles for Public Safety**

	<b>Can Do</b>	<b>Can't Do</b>
<b>Flagler County</b>	Can implement non-structural risk reduction efforts including building and zoning regulations. Can implement emergency management plans and strategies. Can sponsor and cost share in a Federal dune and beach project.	Can't afford a dune and beach nourishment project on their own.
<b>State of Florida</b>	Can implement non-structural risk reduction efforts including building and zoning regulations. Can implement emergency management plans and strategies Can perform maintenance of SR A1A and repair on an emergency basis by dumping rocks.	Can't construct seaward of the FDOT right of way. Can't abandon or relocate SR A1A.
<b>US Army Corps of Engineers</b>	Can implement a cost shared dune and beach nourishment project that reduces damages SR A1A and provides additional protection of the evacuation route beyond what the county and state are capable of providing.	Can't enforce building and zoning regulations. Can't implement local emergency management plans and strategies.

### 6.12.2 Risk and Uncertainty in Economics

Risk and uncertainty is incorporated into the economic evaluation through use of Beach-*fx*. The Beach-*fx* model accounts for uncertainty in the economic evaluations through the use of Monte-Carlo simulations to model future damages. The average annual damages reported in this study are based on the damages averaged across 100 life cycles, with each life cycle experiencing a different suite of storms during the period of analysis. Additionally, uncertainty is accounted for in the damage functions that are used to determine the amount of damage incurred to a structure and its contents from a given storm. Each structure type is assigned a minimum, maximum, and most likely damage function, meaning that the amount of damage experienced by a structure due to a specific amount of erosion or water depth can vary between life cycles. Further discussion is available in **Appendix C**.

### 6.12.3 Risk and Uncertainty in Project Costs

In order to account for uncertainties in the final project costs, which could result from a variety of factors, all costs include an appropriate contingency on top of the actual estimated cost. The contingencies are based on a Cost Schedule Risk Analysis (CSRA), which is included in **Appendix B**. The costs presented in **Table 6-8** include a 23% contingency based on the cost and schedule risk analysis (CSRA) conducted for this project using an 80% confidence level. The top three risk drivers which this contingency is based on are the risk associated with competition and market conditions, dredging quantities for the final design, and increasing fuel prices. These risks will be mitigated for in the PED phase by obtaining up to date surveys prior to construction to reassess project needs. Also, acquisition planning and early solicitation can help maximized bid competition.

Through the CSRA it was determined that 23% is an appropriate contingency to account for uncertainty in initial construction as well as all periodic nourishment over the 50 year period of Federal participation.

### 6.12.4 Risk and Uncertainty in Borrow Availability

An estimated 2 mcy of borrow material would be needed over the 50 year project. Borrow areas 2A, 2B, and 2C contain approximately 5.6 mcy of compatible material for beach placement. Therefore, the risk of running out of material over the 50 year project life is minimal, even if further investigations during PED reveal that less material than originally estimated is actually available at the borrow sites.

### 6.12.5 Risk and Uncertainty in Sea Level Rise Assumptions

The current guidance on sea level change in ER 1100-2-8162 and ETL 1100-2-1 was used throughout the formulation process and to assess the performance of the

final array of alternatives and the recommended plan for the three potential sea-level rise scenarios.

In general the risk of storm damages will increase under increased sea-level rise (SLR) scenarios. **Section 5.3.6.1** and **Appendix C** describes how the recommended plan remains justified in the intermediate and high SLR scenarios. Since beach nourishment projects are naturally adaptable, the renourishment interval can be reduced if SLR leads to increased erosion. For the recommended plan, the average nourishment interval becomes 9 years for the intermediate SLR scenario and 6 years for high SLR scenario. The renourishment interval and placement volume will be re-evaluated with new information in the future.

The residual risks described in **Section 6.12.1** are also sensitive to increased SLR. With rising sea-levels the risk of back-bay flooding in particular is likely to increase. Currently the County and State do not have specific plans for adapting to SLR. However, further into the future additional adaptive management plans may be warranted to address residual risks that are sensitive to SLR.

### 6.13 Implementation Requirements

A Design Agreement with the non-federal sponsor will be executed prior to starting the preconstruction engineering and design (PED) phase, which includes developing the plans and specifications for the project. Once the PED phase is nearing completion and upon approval of this document by headquarters, and authorization and funding, USACE and the non-federal sponsor execute a Project Partnership Agreement (PPA). The PPA is needed before the project can be advertised for construction.

#### 6.13.1 Compliance with Executive Order (EO) 11988

EO 11988 requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, require an 8-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the floodplain. The 8 steps reflect the



decision-making process required in Section 2(a) of the EO. The 8 steps and responses to them are summarized below.

**1. Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year).**

Yes, the study area, and the Recommended Plan project footprint, is within the base floodplain. However, this project reduces damages caused by erosion, and flooding (or inundation) does not cause significant future without-project damages.

**2. If the action is in the base floodplain, identify and evaluate practicable alternatives to the action or to location of the action in the base floodplain.**

**Chapter 5** of this document has an analysis of alternatives. Practicable measures and alternatives were formulated and evaluated, including non-structural measures such as buyout and land acquisition.

**3. If the action must be in the floodplain, advise the general public in the affected area and obtain their views and comments.**

A scoping letter was sent to all Federal and state agencies, local libraries and agencies, and all abutting property owners on August 26, 2008. A public scoping meeting was held in Bunnell, Flagler County, Florida on October 25, 2011 in fulfillment of NEPA requirements at which a rich diversity of views were expressed including those for and against a storm damage reduction project.

**4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base floodplain will affect the base floodplain, impacts resulting from these actions should also be identified.**

Potential impacts associated with the Recommended Plan are summarized in **Chapters 6 and 7** of this report. The project will not alter or impact the natural or beneficial floodplain values.

**5. If the action is likely to induce development in the base floodplain, determine if a practicable non-floodplain alternative for the development exists.**

The project will not encourage development in the floodplain, as development is expected to continue the same as it would in both FWOP and FWP conditions. The project provides benefits for existing development. The project will not change the base flood plain. Practicable measures and

alternatives were formulated and evaluated in **Chapter 5** of this report, including non-structural measures such as buyout and land acquisition.

- 6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the “no action” alternative.**

There is no mitigation expected to be necessary for the Recommended Plan. The project will not induce development in the floodplain and the project will not impact the natural or beneficial flood plain values. Alternatives went through several evaluation screenings in **Chapter 5** of this report.

- 7. If the final determination is made that no practicable alternative exists to locating the action in the floodplain, advise the general public in the affected area of the findings.**

The Draft Feasibility Study and Environmental Assessment (EA) was released for public review and a public meeting was held on February 5, 2014. Comments received and responses to the comments have been incorporated into the report as discussed in **Chapter 8**.

- 8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.**

The Recommended Plan is the most responsive to all of the study objectives described in **Chapter 4**, and it is consistent with the requirements of EO 11988. This project reduces damages caused by erosion, and flooding (or inundation) does not cause significant future without project damages.

#### 6.13.2 Federal Implementation Responsibilities

USACE is responsible for budgeting for the Federal share of future Federal construction projects. Federal funding is subject to budgetary constraints inherent in the formation of the national civil works budget in a given fiscal year. USACE would perform the necessary preconstruction engineering and design (PED) needed prior to construction. USACE would meet requirements for the use of Federal lands at the borrow area, obtain water quality certification, coordinate with the state as required by the Coastal Zone Management Act, and construct the project. Cost sharing of PED, initial construction, and periodic nourishment will be in accordance with WRDA 1986, as amended, subject to the availability of appropriations.

### 6.13.3 Non-federal Implementation Responsibilities

The non-federal sponsor for the shore protection project will be Flagler County. The non-federal project sponsor would provide an up-front cash contribution for initial construction costs of the proposed project. The amount of the non-federal up-front cash contribution would be based on cost sharing principles reflecting shoreline use, ownership and public access in existence at the time of construction. The non-federal sponsor shall provide the entire cost of all material placed on or seaward of undeveloped lands and developed private lands (which are inaccessible to the public). The non-federal sponsor shall provide lands, easements, and rights-of-way and bear a portion of the administrative costs associated with land requirements. Other general non-federal responsibilities, such as continuing public use of the project beach for which benefits are claimed in the economic justification of the project, and controlling water pollution to safeguard the health of bathers, must also be assumed by the non-federal sponsor before the project can be constructed. The non-federal project sponsor will be responsible for all costs of operation, maintenance, repair, rehabilitation and replacement of project features. Section 402 of the 1986 Water Resources Development Act (33 USC 701b-12) as amended by Section 14 of the 1988 Water Resources Development Act states that "Before construction of any project for local flood protection or any project for hurricane or storm damage reduction, that involves Federal assistance from the Secretary, the non-federal interests shall agree to participate in and comply with applicable Federal floodplain management and flood insurance programs." The non-federal sponsor and communities must be enrolled in and in compliance with the National Flood Insurance Program (NFIP) to receive Federal funding for a recommended storm damage reduction project. Flagler County is enrolled in and in compliance with the NFIP.

### 6.13.4 Cost Sharing

Federal participation in HSDR projects is limited to shorelines open to public use. Guidance is provided in ER 1105-2-100 wherein user fees, parking, access, beach use by private organizations, and public shores with limitations are addressed (E-24.d). Federal participation is determined by project purpose, either hurricane and storm damage reduction or recreation, and by shoreline ownership. Shoreline ownership is separated into lands that are federally owned, publicly and privately owned, and privately owned with limited use, as shown in **Table 6-6**. More specific guidance is provided in ER 1165-2-130 on what constitutes sufficient parking.

**Table 6-6: Shore Ownership and Levels of Federal Participation**

Shore Ownership and Project Purpose (as defined in EC 1165-2-130)	Maximum Level of Federal Participation in Initial Construction Costs	Maximum Level of Federal Participation in Periodic Renourishment
I. Federally Owned	100%	100%
II. Publically and Privately Owned, Protection Results in Public Benefits		
A. Hurricane and Storm Damage Reduction	65%	50%
B. Loss of Land or Incidental Recreation	50%	50%
C. Separable Recreation	50%	50%
III. Privately Owned, Use Limited to Private Interests	0%	0%
IV. Privately Owned, Undeveloped	0%	0%

In order to evaluate the study area, available information was gathered from aerial photography, Flagler County sources and field reconnaissance. The public use of the shoreline was addressed first to determine the level of Federal participation, then secondly the shoreline ownership, and then the cost-sharing percentage was calculated for initial nourishment and future periodic renourishments (**Table 6-7** and **Table 6-8**). The project area is accessible to the public with adequate parking. There are two small areas, discussed in Chapter 5, that have adequate access and parking, but no signage to inform the public that parking is available (see parking and access figures in **Chapter 5**). The sponsor has indicated that signage will be provided prior to initial construction.

**Table 6-7: Recommended Plan Initial Construction Cost Sharing**

Design Reach	Reference	Parcel Number	Lot Width (Feet)	Shoreline Description	Within Project Limits	Within 1/4 Mile of Access	Shore Ownership and Project Purpose	Level of Federal Participation	Federal Participation Times Lot Width	
C	7th Street	1212314500007500390	13970	Developed	Y	Y	II.A.	65%	9081	SR A1A Hurricane Evacuation Route
C										
C										
C										
C										
C										
C										
C										
C										
C										
C										
C	28th Street	1912320150000500210								

Shore Ownership and Project Purpose (as defined in EC 1165-2-149)	Maximum Level of Federal Participation in Construction Costs	Shoreline Length (feet)	Federal Participation (feet)	non-Federal Participation (feet)
I. Federally Owned	100%	0	0	0
II. Publically and Privately Owned, Protection Results in Public Benefits				0
A. Hurricane and Storm Damage Reduction	65%	13,970	9,081	4,890
B. Loss of Land or Incidental Recreation	50%	0	0	0
C. Separable Recreation	50%	0	0	0
III. Privately Owned, Use Limited to Private Interests	0%	0	0	0
IV. Privately Owned, Undeveloped	0%	0	0	0
	Total Distance	13,970	9,081	4,890
			<b>65.0%</b>	<b>35.0%</b>

**Table 6-8: Recommended Plan Periodic Renourishment Cost Sharing**

Design Reach	Reference	Parcel Number	Lot Width (Feet)	Shoreline Description	Within Project Limits	Within 1/4 Mile of Access	Shore Ownership and Project Purpose	Level of Federal Participation	Federal Participation Times Lot Width	
C	7th Street	1212314500007500390	13970	Developed	Y	Y	II.A.	50%	6985	SR A1A Hurricane Evacuation Route
C										
C										
C										
C										
C										
C										
C										
C										
C										
C										
C	28th Street	1912320150000500210								

Shore Ownership and Project Purpose (as defined in EC 1165-2-149)	Maximum Level of Federal Participation in Construction Costs	Shoreline Length (feet)	Federal Participation (feet)	non-Federal Participation (feet)
I. Federally Owned	100%	0	0	0
II. Publically and Privately Owned, Protection Results in Public Benefits				0
A. Hurricane and Storm Damage Reduction	65%	13,970	6,985	6,985
B. Loss of Land or Incidental Recreation	50%	0	0	0
C. Separable Recreation	50%	0	0	0
III. Privately Owned, Use Limited to Private Interests	0%	0	0	0
IV. Privately Owned, Undeveloped	0%	0	0	0
	Total Distance	13,970	6,985	6,985
			<b>50.0%</b>	<b>50.0%</b>

### 6.13.5 Project Costs

Total project first costs and cost share breakdown in FY15 price levels are tabulated below in **Table 6-9**. The cost of the final periodic renourishment is slightly less than the first 3 periodic renourishments only because less post-construction monitoring is required for the final event. The Total Project Cost Summary and a more detailed cost break down for initial construction and each periodic renourishment is located in **Appendix B**.

**Table 6-9: Cost Summary and Cost Sharing (Project First Costs)**

Flagler County, Florida Hurricane and Storm Damage Reduction Project					
Summary of Project Cost Sharing (Constant Dollar Basis, FY15 (1 Oct 14) price levels)					
Initial Construction					
Cost Share Description	Federal Cost Share %	Federal Cost	Non-Federal Cost Share %	Non-Federal Cost	Project First Cost
Storm Damage Reduction Costs	65%	\$9,218,300	35%	\$4,963,700	\$14,182,000
Real Estate Costs (LERRD Credit)	0%	\$0	100%	\$3,336,000	\$3,336,000
Cash Portion		\$9,218,300		\$1,627,700	\$10,846,000
Periodic Nourishment					
Periodic Nourishment	50%	\$15,390,000	50%	\$15,390,000	\$30,780,000
Initial Construction + Periodic Nourishment					
Final Project Cost Share and Cost (50 years)	55%	\$24,608,300	45%	\$20,353,700	\$44,962,000

A summary of the average annual costs and benefits for the Recommended Plan in FY14 (1 Oct 13) price levels is provided in **Table 6-10**. The benefit cost ratio was calculated for the current discount rate of 3.5%.

**Table 6-10: Economic Summary of the Recommended Plan**

<b>Economic Summary (FY 14 Price Level, 50 -Year Period of Analysis, 3.5% Discount Rate)</b>	
Initial Construction	\$14,114,220
1st Renourishment	\$7,589,733
2nd Renourishment	\$7,589,733
3rd Renourishment	\$7,589,733
4th Renourishment	\$7,503,633
<hr/>	
Total First Cost	\$44,387,052
Interest During Construction (IDC)	\$163,000
Total Investment Cost	\$44,550,052
Average Annual Investment Cost	\$1,229,000
Annual OMRR&R (100% Non-Federal)	\$10,000
<b>Total Average Annual Cost</b>	<b>\$1,239,000</b>
<hr/>	
Average Annual Storm Damage Reduction	\$2,159,000
Average Annual Recreation Benefits	\$72,000
Average Annual Traffic Reroute Benefits	\$131,000
<b>Average Annual Total Benefits</b>	<b>\$2,362,000</b>
<hr/>	
<b>Average Annual Net Benefits</b>	<b>\$1,123,000</b>
<b>Benefit Cost Ratio (3.5 % discount rate)</b>	<b>1.9</b>

#### 6.13.6 Financial Analysis of Non-federal Sponsor's Capabilities

A financial analysis is required for any plan being considered for USACE implementation that involves non-federal cost sharing. The ultimate purpose of the financial analysis is to ensure that the non-federal sponsor understands the financial commitment involved and has reasonable plans for meeting that commitment. By memorandum dated April 24, 2007 the Assistant Secretary of the Army (Civil Works) granted approval of the self-certification of non-federal sponsors for their ability to pay the non-federal share of projects. The self-certification is required prior to submission of the Project Partnership Agreement, typically during the PED phase of the project. Included with the self-certification, the financial analysis shall include the non-federal sponsor's statement of financial capability, the non-federal sponsor's



financing plan, and an assessment of the sponsor's financial capability. The Flagler County Board of Commissioners provided a letter certifying Flagler County's willingness and ability to pay the non-federal share of this Federal Hurricane and Storm Damage Reduction Project.

#### 6.13.7 Views of Non-Federal Sponsor

Flagler County is the non-federal sponsor for the Flagler County, Florida Hurricane and Storm Damage Reduction Project. They have been an integral part of the PDT from the conception of the project. At each step of the process, Flagler County has contributed to the available information, participated in the formulation, and reviewed the products. Flagler County supports the Recommended Plan, and is aware that a majority of the benefits for this plan come from reducing road and armor maintenance costs. The Board of County Commissioners selected this plan on April 17, 2013.

# CHAPTER 7

## ENVIRONMENTAL CONSEQUENCES



NESTING TURTLE TRACKS IN FLAGLER COUNTY



FLAGLER COUNTY, FLORIDA  
HURRICANE AND STORM DAMAGE REDUCTION PROJECT  
FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

**CHAPTER 7**  
**ENVIRONMENTAL CONSEQUENCES**

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## 7 ENVIRONMENTAL CONSEQUENCES \*

This chapter is the scientific and analytic basis for the comparisons of the no action plan and the Recommended Plan which is the preferred alternative. See **Table 7-1** for a summary of impacts and anticipated changes to the existing environment including direct, indirect, and cumulative effects.

Formulation, evaluation, and comparison of alternatives, culminating in selection of the Recommended Plan, are presented in **Chapter 5** of this integrated document. Through the plan formulation process, the alternatives were screened until the final alternative became the Recommended Plan. Five measures were carried past the preliminary screening based on rough order of magnitude (ROM) costs as described in **Section 5.3.2.1**. The environmental consequences of these five intermediate measures are as follows.

- No action: The no-action plan represents future conditions without the implementation of a project. Environmental consequences associated with this measure are the continued deterioration of sea turtle nesting habitat due to shoreline erosion. No adverse effect would occur to North Atlantic right whale or its critical habitat. No adverse effect would occur to piping plover although continued erosion would further discourage this species from using this shoreline for wintering habitat. Migratory shorebirds would likewise be discouraged from using the shoreline as the habitat quality degrades.
- Geotube with Dune Alternative: This management measure includes construction of a dune composed of geotextile sand-filled tubes that would be covered with a constructed dune. Environmental consequences associated with this measure are outlined in **Sections 7.1.1 and 7.2 to 7.17** with respect to vegetation, federally-protected species, cultural resources, air and water quality, and other considerations. Although the section is specific to the Recommended Plan, the environmental consequences are the same for this alternative.
- Revetment Alternative: This measure would involve placement of large rock, designed to withstand the wave environment, along the existing bluff line. Environmental consequences associated with this measure are outlined in **sections 7.1.1 and 7.2 to 7.17** with respect to federally-protected species, cultural resources, air and water quality, and other considerations. The environmental consequences of the revetment alternative would be similar to the Recommended Plan, but would also include the loss of sandy habitat necessary for shorebird and sea turtle nesting.
- Dune Alternative: This measure would include placement of beach compatible material in a dune feature adjacent to the existing bluff. Vegetation would be planted after placement of the dune material. Environmental consequences associated with this measure are detailed in the sections below as this is the Preferred Alternative, or the designated Recommended Plan.
- Beach Nourishment with Dune Alternative: This measure would include placement of beach compatible material to extend the existing berm seaward in addition to dune construction. Environmental consequences associated with this measure are

outlined in **Sections 7.1.1 and 7.2 to 7.17** with respect to federally-protected species, cultural resources, air and water quality, and other considerations. Although the section is specific to the Recommended Plan, the environmental consequences are the same for this alternative.

It was determined through the intermediate screening described in **Section 5.3.3** that the geotube with dune and revetment measures could not be carried forward as implementable alternatives. Both of these alternatives would need to be combined with the dune alternative to be considered beneficial. Preliminary modeling showed that the dune alternative by itself prevented almost all of the future without-project (FWOP) damages. Therefore, the geotube and revetment alternatives would have additional costs without additional benefits, and they were not carried forward to the final screening described in **Section 5.3.4**. The final array of alternatives, shown in **Table 5-7**, consists of various combinations of dune and beach nourishment. Through this process, the Dune Alternative became the Recommended Plan; see **Chapter 6** regarding details for this recommended plan

The National Environmental Policy Act (NEPA) requires evaluation of alternatives, including the no-action alternative. The Environmental Consequences section describes the existing environmental resources of the areas that would be affected if any of the alternatives were implemented. The Recommended Plan presented in this chapter represents the Preferred Alternative described in Section 6.2. This section, in conjunction with the description of the FWOP condition described in Chapter 3, forms the baseline conditions for determining the environmental impacts of the proposed action and reasonable alternatives. It is referred to as the No Action Alternative in this chapter. A summary of the direct and indirect environmental impacts for both the Preferred Alternative and the No Action Alternative is presented in **Table 7-1**.



**Table 7-1: Summary of Direct and Indirect Impacts.**

<b>EXISTING ENVIRONMENTAL FACTOR</b>	<b>ALTERNATIVE Dune construction from material mined from offshore borrow site (Preferred Alternative)</b>	<b>ALTERNATIVE No Action</b>
VEGETATION	Temporary impact to dune and upper beachface vegetation will occur from construction activities. Disturbed or removed vegetation will be replanted as a component of the project, which will benefit native species diversity and overall habitat stability	Continued erosion of the dune and upper beach will further stress dune vegetation causing die-back of species.
PROTECTED SPECIES	<p>Direct adverse impacts include:</p> <ul style="list-style-type: none"> <li>• Alteration of the beach face resulting in potential adverse impact to sea turtle nesting and hatching success (including effects from grade changes, sediment material, over-compaction, escarpment formation, artificial lighting during construction) resulting in potential “incidental” take of sea turtles</li> <li>• Potential taking of sea turtles with hopper dredge (if utilized)</li> <li>• Possible encounters with North Atlantic Right Whales by dredge and support vessels during dredge and disposal operations. Unlikely to encounter manatees in the open ocean; no effects are expected to occur.</li> </ul> <p>Direct positive impacts:</p> <ul style="list-style-type: none"> <li>• Nesting area along project reach would increase with nourishment activities</li> </ul>	Continued loss of sea turtle nesting habitat on the beach.
HARDBOTTOM RESOURCES	No hardbottom resources are known to be present within or adjacent to the project limits or borrow area based on project-specific surveys. Resources that may exist outside of the project or borrow area will be avoided. No effects are expected to occur.	No impacts would occur. Known hardbottom resources occur within the study area but do not occur within the borrow area or project limits.

<b>EXISTING ENVIRONMENTAL FACTOR</b>	<b>ALTERNATIVE Dune construction from material mined from offshore borrow site (Preferred Alternative)</b>	<b>ALTERNATIVE No Action</b>
FISH AND WILDLIFE RESOURCES	Short-term impact to dune and beach habitat due to burial/disturbance, but long term benefit through increase in these habitats for nesting shorebirds and benthic fauna. Temporary impact to fish in the water column and benthic resources during dredging activities.	Continued loss of dune and beach habitat.
ESSENTIAL FISH HABITAT	Short-term turbidity would be present at the borrow area. No hardbottom resources were identified to be present in the borrow area during the subsurface resource survey; therefore, no impact would occur to this resource. No placement of material will occur in the nearshore. No impact would occur to this resource.	No impacts would occur.
COASTAL BARRIER RESOURCES	Coastal barrier resources (Units FL-P07P and P05A) would be enhanced through restoration of natural habitat. No structural components are proposed with this project.	Continued loss of beach habitat associated with CBRA Units FL-P07P and P05A.
WATER QUALITY	Direct adverse impacts include a temporary increase in turbidity adjacent to the borrow site and beach fill area. Turbidity would be monitored during project construction and work would cease if turbidity is not in compliance with Florida water quality standards.	No impacts to water quality would occur.
AIR QUALITY	Direct adverse impacts include small, localized, temporary increases in concentrations of nitrogen dioxide (NO <sub>2</sub> ), sulfide (SO <sub>2</sub> ), carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter (PM) mostly associated with the dredge plant.	No impacts would occur.
NOISE	Temporary increase in noise at the borrow area and at the placement sites.	No impacts would occur.

<b>EXISTING ENVIRONMENTAL FACTOR</b>	<b>ALTERNATIVE Dune construction from material mined from offshore borrow site (Preferred Alternative)</b>	<b>ALTERNATIVE No Action</b>
AESTHETIC RESOURCES	Temporary decrease in the aesthetic appeal of the beach while placement activities occur; long-term increase in the appearance of the beach.	Long-term decline in appearance of the beach as it continues to erode.
RECREATION RESOURCES	Inability to utilize beach during construction; long-term benefit to recreational interests using the beach. Minor temporary impact to recreational boaters required to avoid the dredge and associated vessels during construction activities.	Long-term decline in beach available for use by recreational interests.
NAVIGATION	Temporary impacts to vessels utilizing the Atlantic Ocean near the Borrow Area 2 sub-areas and utilizing the nearshore areas during sand pump-out.	No impacts would occur.
HISTORIC AND CULTURAL RESOURCES	Adverse effects to potentially significant historic properties in the nearshore and borrow areas. Buffer of 200-ft around any identified significant historic properties if encountered. May require use of borrow area 2 B to meet sand volume needs.	No direct impact historic resources but does allow for continued shoreline erosional forces
NATIVE AMERICANS	No adverse effects on Native American properties.	No adverse effects on Native American properties.

## 7.1 General Environmental Effects

### 7.1.1 Environmental Effects

The beneficial effects from the placement of sand fill along the proposed project areas include the establishment of a dune and buffer area for protection against storms and erosion, and creation of additional dry beach for recreational activities. The placement of sand may increase sea turtle nesting habitat provided that the sand is highly compatible with naturally occurring beach sediments and that compaction and escarpment remediation measures are incorporated into the project.

Potential negative effects on sea turtles during construction include:

- Possible destruction of nests deposited within the boundaries of the proposed project
- Harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches
- Disorientation of hatchlings on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting, and
- Behavioral modification of nesting females due to escarpment formation within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs

Sea turtle nesting density within the project limits has decreased when compared to areas outside of the recommended plan but within the study area, as discussed in **Section 2.4.3** Extensive armoring and revetment has disrupted sea turtle nesting due to disturbance to the habitat quality. These areas are anticipated to become desirable nesting areas once the dune and beach are reconstructed as the quality of habitat will be increased significantly. However, minor effects on sea turtle nesting may occur as a result of the project. The quality and color of the sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest. Subsequently, geotechnical evaluation of the offshore sand sources identified for the proposed project found sediment quality compatible with the natural beach conditions. The elevation of the dune feature and modest, seaward-sloping berm widths associated with the proposed beach fill are not unreasonably anticipated to increase hatchling disorientation associated with beach lighting.

Protective measures can alleviate the potential for some of the negative impacts to nesting sea turtles:

- nest monitoring and relocation
- using minimum and/or shielding construction lighting
- compaction monitoring and tilling activities to reduce sand compaction
- leveling escarpments prior to nesting season
- conducting construction outside of the main nesting season, and
- conducting daily surveys and avoiding nests during construction activities for early or late nesting season

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Adverse effects on shorebirds may occur by:

- Harassment during construction and physical impacts to nesting or fledgling animals
- Temporary loss of benthic macroinfaunal invertebrates along areas of beach-face fill, and
- Relocation (concentration) of waterbird feeding to non-affected areas of the shoreline

These impacts are typically temporary, and will be lessened by monitoring during construction and the fact that portions of the project area will include only dune fill placement (versus inter-tidal or sub-tidal placement).

The presence of construction equipment and personnel will temporarily detract from the aesthetics of the beach and temporarily limit recreational beach activity by the public within areas of construction activity. Best management practices will be implemented to ensure efficient construction and the minimization of extended presence of equipment and personnel in the project area and related habitats. Aesthetic impacts due to temporary discoloration of the beach sand after placement is not anticipated in the proposed project.

#### 7.1.2 Environmental Surveys

The environmental evaluation included numerous investigations and activities undertaken by USACE and the local sponsor, Flagler County, to identify the environmental resources within the project area that would be affected by the proposed action. These efforts include the studies and tasks described below.

Two substrate surveys were conducted to identify the presence and nature of the exposed submerged nearshore hardbottom along the study area. A mapping survey of the nearshore rock resource using sidescan sonar technology was conducted for the Flagler County HSDR project in July and August, 2011 (DCA, 2011). The focus of this study was to determine the presence and location of hardbottom resources within the study area from FDEP monument R-50 to R-100. The result of this survey was the basis for an additional characterization survey of supposed hardbottom features which was conducted by the USACE Jacksonville District in July, 2012. This second survey focused on supposed rock outcroppings at locations identified in August 2011 using an additional, comparative sidescan sonar survey. Methods employed for the DCA survey differed from those employed by the USACE Hydrographic Survey Section as described in Section 2.4.4, and may account for the contrasting results. Preliminary results from the 2012 USACE survey found no presence of hardbottom at the previously identified locations. It is the surveyor's opinion (USACE Hydro-survey Section), based on the available survey data, that there is no hardbottom reef in the study area. Details of the two surveys, including details of methods and findings, are included in the **Environmental Appendix F**.

The sedimentary characteristics of the proposed beach fill material from the proposed offshore borrow areas were studied through sample vibracore collections within three separate candidate locations. The purpose of the study was to identify sufficient beach compatible material for the entire life cycle of the project. Sediment samples were collected from the borings and laboratory testing was performed to create an arithmetic composite sample from all collected material. Of the three sites, one area, Borrow Area 2, was found to contain abundant beach quality material required for renourishment for the life of the project. The analytical results characterize the sediments in the borrow area as poorly-graded, fine grained sands with an average of 16% visual shell and 27% carbonate content.

Prior to construction, additional surveys may be required to assess the most current conditions to assure avoidance of hardbottom and cultural resources. Such surveys will be performed as needed to address any changes in conditions or to complete any work as previously identified in the study.

## 7.2 Vegetation

### 7.2.1 No-Action Alternative

The no-action alternative would result in increased or continued erosion of the beach and dune, consequently resulting in increased stress and continued loss of native desirable vegetation.

### 7.2.2 Preferred Alternative

Dune and beach fill placement activities will occur seaward of existing beach and dune vegetation, which is consistent with anticipated requirements by state and Federal resource protection agencies to limit, to the greatest extent practical, disturbance to existing beach and dune vegetation. No permanent impact on vegetation is expected from the proposed activity. Project construction will require planting of vegetation on newly constructed dune areas and replanting in equivalent density and type (limited to naturally occurring native coastal species) to replace existing vegetation that was disturbed during the construction activity. Furthermore, there are no seagrass communities present that would be subject to direct or secondary impacts from the project activities.

### 7.3 Threatened and Endangered Species

The following sections describe impacts on threatened and endangered species associated with the proposed action. This description includes the preferred alternative for which impacts are essentially identified. Impacts associated with the no-action alternative are described at the end of this section.

#### 7.3.1 Preferred Alternative

##### 7.3.1.1 Sea Turtles

As the preferred alternative proposes to place sand on the dune and beach, USACE has determined that it may affect nesting sea turtles. If a hopper dredge is utilized, the project may also affect sea turtles in the marine environment. The terms and conditions of the Southeastern Atlantic Regional Biological Opinion (SARBO) will be adhered to during construction activities; see **Section 7.27.2**.

##### (1) Nesting Habitat

Sea turtles that may occur within the project area are listed in **Chapter 2** of the main report. All sea turtle species are currently listed as endangered or threatened by the USFWS and FWC.

The construction of a stable dune and a wider beach will ensure that sufficient beach habitat is available for sea turtles to nest. There are a number of potential impacts to nesting sea turtles as a result of changes in beach characteristics following renourishment. Scarp development could hinder sea turtles from accessing suitable nesting habitat. Sand compaction could make excavating a proper nest difficult. Changes in sand color or sand chemistry could affect the viability of a clutch.

To minimize these potential effects, geotechnical surveys of the borrow areas were conducted to identify sand that is suitable for placement at this site. The sand grain size and color must meet specific criteria to prevent compaction and to help ensure its acceptability by sea turtles. Comparison of the geotechnical data of both the native material and the borrow area sampling indicates that the materials are similar from these two sources. Post-construction surveys will monitor the presence of scarps, and tilling will be conducted if scarps or compaction occur.

The terms and conditions of the Statewide Programmatic Biological Opinion (SPBO) will be adhered to during construction activities; see **Section 7.27.2**.

##### (2) Nearshore and Offshore Habitat

The preferred alternative plan would place beach fill along the dune as well as on the beach. The placement and subsequent cross-shore equilibration of this sand fill will result in sedimentation and/or partial burial of the portions of the existing unconsolidated substrate of the nearshore along the beach, anticipated to be mostly along the landward edge extending into the nearshore some 300 to 500 feet, or to a depth of -0.5 feet at MLLW. If a hopper dredge is used, dredging may impact sea turtles due to entrainment,

benthic foraging and resting habitat disturbance, noise disruption, and injury from vessel and dredges.

Sidescan sonar surveys did not identify any significant hardbottom areas in either the proposed borrow areas or along the immediate nearshore (within 1500 feet of the MLLW). If a hopper dredge is used for the dredging operations, potential impacts to sea turtles could occur. To minimize the risk to sea turtles, standard sea turtle protection conditions will be implemented such as deflector dragheads, inflow screens, and/or monitoring of the operation. At present, no hardbottom resources are present in the nearshore within the project reach limits, or in Borrow Area 2 (Sub-areas 2A, 2B, and 2C). If unknown hardbottom resources are encountered, a 400-foot buffer will be maintained around low-relief hardbottom areas that could serve as attractants to sea turtles for foraging. The project will adhere to all turtle safety precautions outlined in the NMFS SARBO (25 August, 1995; Revision 29 October, 1997), as well as implement the NMFS Sea Turtle Construction Conditions during project construction.

#### 7.3.1.2 North Atlantic Right Whales

The shoreline along the Flagler County coast is within designated critical habitat for the North Atlantic Right Whale. Borrow Area 2, located some 6 to 7 miles offshore, is beyond the limits of the critical habitat. However, transporting beach material from the borrow area will entail crossing through the critical habitat. As described in Chapter 2 of the main report, the two main threats to this species are ship strikes and fishing gear entanglement. Collision with dredge vessels poses moderate risk to right whales if a hopper dredge is used for acquiring material from the borrow area. This risk is significantly reduced by use of a hydraulic suction cutter dredge and pipeline for transporting material to the beach in the project reach limits. To best ensure that adverse impacts to whales are avoided during construction activities, the requirements and recommendations in the NMFS South Atlantic Regional Biological Opinion (SARBO) will be followed. Furthermore, if an animal is encountered during construction, USACE has standard language in the contracting specifications to protect the animal.

#### 7.3.1.3 Piping Plover

The Preferred Alternative may affect, but is not likely to adversely affect the wintering piping plover population in Flagler County. Piping plover have been observed occasionally on the beach at Gamble Rodgers Memorial State Recreation Area which has the most suitability for their habitat requirements. This area is beyond the proposed project southern limit (FDEP monument R-95) and, therefore, would not be impacted directly or indirectly from construction activities. Furthermore, the proposed action would not adversely modify critical habitat as it is not located within a designated area.

#### 7.3.1.4 Red Knot

The Preferred Alternative may affect, but is not likely to adversely affect the wintering red knot population in Flagler County. The most recent sighting of a Red Knot on a Flagler County Beach was in 2007 at the Gamble Rodgers Memorial State Recreation Area. The degraded beach habitat quality within the project limits would prohibit use by Red Knot.



### 7.3.2 No-Action Alternative

No impacts would occur on the threatened and endangered species discussed in this section, except for the slow decline in the quality of available habitat for nesting sea turtles, red knot, and the wintering piping plover.

## 7.4 Marine Mammals

### 7.4.1 Preferred Alternative

Borrow area activities are not likely to affect marine mammal species. Any minor impact due to dredging activity at the borrow areas and vessels traversing from the borrow areas to the placement sites would be temporary in nature. Use of a hydraulic cutterhead dredge and pipeline would avoid potential contact with marine mammals. In the event that a hopper dredge is used, a Marine Mammal Observer (MMO) would be present during the dredge operation and material transport to the project area.

### 7.4.2 No-Action Alternative

No impacts on marine mammals would occur as a result of the no-action alternative.

## 7.5 Birds

### 7.5.1 Preferred Alternative

Bird species that may visit the project area during the beach nourishment period are likely to be displaced from the target shoreline by disturbance from ongoing activities. These disturbances may result in temporary displacement, or may result in the abandonment of the target beach area by individual birds. These impacts include:

- disturbance from ongoing dune and beach-face fill placement, pump-out, and grading activities
- the loss of benthic macroinfaunal invertebrates within the beach fill placement areas that are used as a food source for certain listed species, and
- alteration of water clarity resulting from suspended sediment during dredging operations that could negatively affect the foraging capabilities of some species

Migratory birds would be minimally affected by proposed activities. Dune and beach construction activities will include specific monitoring measures during construction with regard to migratory birds. For instance, activities at the beach will be monitored at dawn or dusk daily during the nesting season to protect nesting migratory birds. Should nesting activities occur within the construction area, appropriate buffers will be placed around nests to ensure their protection. The impact of increases in turbidity would be a temporary impact as water clarity is expected to recover soon after completion of all activities.

### 7.5.2 No-Action Alternative

The no-action alternative would result in a steadily eroding shoreline that would limit the availability of beach habitat available for nesting, roosting and foraging migratory birds.

## 7.6 Essential Fish Habitat Assessment

The project description is located in Chapter 6 of the main report. **Chapter 2** describes the existing conditions of the Essential Fish Habitat (EFH), federally managed fisheries, and associate species such as major prey species, including affected life history stages. The following subsections describe the individual and cumulative impacts of the proposed action(s) and alternatives on EFH, federally managed fisheries, and associate species such as major prey species, including affected life history stages.

### 7.6.1 Preferred Alternative

Marine habitats of coastal non-vegetated demersal soft bottoms, open shelf, shelf edge, and lower shelf water columns within the study area have been designated as EFH. Borrow areas that include part of the Korona Ridge Field geomorphologic unit (Area 2) and part of the Flagler Sand Wave geomorphologic unit (Area 3) would be affected by material excavation. These areas rely on currents to form mounds which are gradually deposited over time. Removal of the upper portion of the ridge would have minimal impact as the removal of material is conservatively estimated over the expanse of the shoal's upper portion, which is approximately 7,500 feet long by 2,500 feet wide.

Although no hardbottom habitat is known to be present in the vicinity of the borrow areas or immediately nearshore of the project area, pursuant to the NMFS South Atlantic Regional Biological Opinion, USACE will attempt to maintain 400-foot buffers where possible if this resource is encountered. With the establishment of the 400-foot buffer, less impact to reef fish would occur due to their ability to move from the dredging site.

The water column is a habitat used for foraging, spawning, and migration. Impacts on the water column may have localized effects on marine species. Injury or entrainment due to dredging would most likely affect demersal or less mobile species, such as shellfish. Dredging may temporarily affect feeding success of EFH species due to turbidity and loss of benthic organisms; however, adjacent similar habitat is available for feeding. Benthic organisms are expected to recover and inhabit the substrate within the borrow areas over time. Other potential adverse effects include: vessel strikes; behavioral alterations due to sound, light, and structures; increased turbidity and sedimentation; changes to soft bottom bathymetry in the borrow area during dredging; and temporary loss of prey items and foraging habitat.

Water quality concerns are of particular importance in the maintenance of this habitat. During dredging, suspended materials may interfere with the diversity and concentration of phytoplankton and zooplankton, and therefore could affect foraging success and patterns of schooling fishes and other grazers that comprise prey for managed species.

Foraging patterns would be expected to return to normal at the end of dredging activities.

#### 7.6.2 No-Action Alternative

No impacts would occur to EFH as a result of the No Action Alternative.

### 7.7 Coastal Barrier Resources

The proposed project does not include the construction of structures that would require Federal Flood Insurance; therefore, Federal expenditures for the proposed project are not restricted in Unit FL-06P, Washington Oaks Garden State Park, or Unit FL-P07P, Gamble Rodgers Memorial State Recreation Area OPA. Although these areas fall within the feasibility study area, they are outside of the project limits for any proposed shoreline protection activities.

### 7.8 Water Quality

#### 7.8.1 Preferred Alternative

Construction activities may cause temporary increases in turbidity in the immediate vicinity of construction. These conditions will cause short-term impacts to the area's water quality. The State of Florida water quality regulations require that water quality standards not be violated during constructions operations. The standards require that turbidity shall not exceed 29 NTU's above background. Should turbidity exceed state water quality standards as determined by monitoring, the contractors will be required to cease work until conditions return to normal. Increased turbidity at the borrow site during excavation should be minor and less than the turbidity increase along the shore during renourishment.

#### 7.8.2 No-Action Alternative

The no-action alternative will not adversely affect water quality in the action area.

### 7.9 Air Quality

#### 7.9.1 Preferred Alternative

The short-term impact of emissions by the dredge and other construction equipment associated with the project will not significantly impact air quality. Flagler County is an attainment area and the FDEP does not regulate marine or mobile emission sources (construction equipment) in attainment areas. No air quality permits will be required for this project.

#### 7.9.2 No-Action Alternative

The no-action alternative would not affect air quality in the project area.

## 7.10 Noise

### 7.10.1 Preferred Alternative

Dredging noise can affect marine mammals, sea turtles, and fisheries. Possible effects of dredging noise can vary depending on a variety of internal and external factors, and can be divided into masking (obscuring of sounds of interest by interfering sounds, generally at similar frequencies), response, discomfort, hearing loss, and injury (MALSF, 2009). Deeper water operations may propagate sound over greater distances than those in confined nearshore areas (Hildebrandt, 2004).

Dredging to extract marine aggregates produces broadband and continuous sound, mainly at lower frequencies. The little available data indicates that dredging is not as noisy as seismic surveys, pile driving, and sonar; however, it is louder than most shipping, operating, offshore wind turbines, and drilling (MALSF, 2009). Noise associated with dredging activities can be placed into five categories:

- Collection noise – The noise generated from the collection of material from the sea-floor; for example, the scraping of the buckets on a bucket ladder dredge or the operation of the drag head. This noise is dependent on the structure of the sea floor and the type of dredge used.
- Pump noise – The noise from the pump driving the suction through the pipe.
- Transport noise – The noise of the material being lifted from the sea floor to the dredge. For trailing suction hopper and cutter suction dredges, this would be the noise of the material as it passes up the suction pipe. For clamshell dredges, it would be the sound of the crane dropping/lifting the bucket.
- Deposition noise – This noise is associated with the placement of the material within the barge or hopper.
- Ship/machinery noise – The noise associated with the dredging ship itself. For stationary dredges, the primary source will be the onboard machinery. Mobile dredges will also have propeller and thruster noise (MALSF, 2009).

Field investigations have been undertaken to characterize underwater sounds typical of bucket, hydraulic cutterhead, and hopper dredging operations (Dickerson *et al.*, 2001). Preliminary findings indicate that cutterhead dredging operations are relatively quiet as compared to other sound sources in aquatic environments. Hopper dredges produce somewhat more intense sounds similar to those generated by vessels of comparable size. Bucket dredges create a more complex spectrum of sounds, very different than either cutterhead or hopper dredges. Hopper dredge noises consist of a combination of sounds emitted from two relatively continuous sources: engine and propeller noise similar to that of large commercial vessels, and sounds of dragheads moving in contact with the substrate.

Reported source levels for dredging operations range from 160 to 180 dB re 1 uPa @ 1 m for 1/3 octave bands (equivalent to the sound wave energy of a killer whale whistle) with peak intensity between 50 and 500 Hz (JASCO, 2011) (Greene and Moore, 1995). The intensity, periodicity, and spectra of emitted sounds differ greatly among dredge types. Components of underwater sounds produced by each type are influenced by a

host of factors including substrate type, geomorphology of the waterway, site-specific hydrodynamic conditions, equipment maintenance status, and skill of the dredge plant operator (Dickerson *et al.*, 2001).

Noise generated by the dredge will be offshore and will not impact those living on the beaches. Noise generated on the beaches by equipment placing the dredged material will be relatively low level and will be of a short duration. Construction equipment such as booster pumps will be properly maintained to minimize effects of noise. Once dredging and material placement have concluded, noise levels will drop back to normal levels for the dune and beach area. Noise may temporarily impact some underwater organisms, but is not anticipated to adversely affect these organisms since the increases to the current level of noise as a result of this project will be localized and minor. There will only be a temporary reduction in aesthetics and no expectation of adverse effects to the environment as a result of construction-related noise.

#### 7.10.2 No Action Alternative

Noise levels in the project area would not be affected by the No Action Alternative.

### 7.11 Aesthetic Resources

#### 7.11.1 Preferred Alternative

Construction equipment on the beach will be aesthetically unappealing for the duration of construction. The duration of initial construction is estimated to be 30 days for mob/demob and 123 days for construction. The duration of subsequent periodic nourishments is estimated to be 30 days for mob/demob and 41 days for construction. The project will result in a wider, more aesthetically pleasing beach. Also, reconstruction of the dune includes planting native upland dune species that will result in improved aesthetics.

#### 7.11.2 No-Action Alternative

Beach ecosystems are generally considered to be aesthetically pleasing. The no-action alternative may ultimately result in a loss of this ecosystem and a less aesthetically appealing shoreline that may require additional hard stabilization methods (i.e., revetments or seawalls) to protect upland properties.

### 7.12 Socio-Economic Resources

#### 7.12.1 Preferred Alternative

Construction equipment on the beach may have a minor effect on tourism interests at Flagler Beach for the duration of construction (less than six months). Post-project, the long-term result of dune restoration will have an overall increased value to properties abutting the beach. Construction of the dune will require removal or burial of existing publicly and privately-owned boardwalk crossovers from SR A1A to the beach. The loss of private access to the beach may pose an impact of hardship to affected property owners. The public crossovers will be replaced as part of the project.

### 7.12.2 No-Action Alternative

Continued loss of beach and degradation of the existing dune will have a negative effect on property values and the tourism industry. The existing public and privately-owned boardwalk crossovers will eventually become unstable and require maintenance or possible removal from future storm surge or high wind events.

## 7.13 Recreation Resources

### 7.13.1 Preferred Alternative

The current use of Flagler County beaches within the project limits (FDEP monument R80 to R94) is subject to erosion after significant storm events. The proposed action of dune rebuilding and beach nourishment would cause temporary impediment of recreational usage where placement and distribution of material occurs within the project limits. There would be a long-term benefit to recreation from the extended width of the beach and stabilization of the system.

The current use of the borrow areas (Sub-areas 2A, B and C) for recreation is limited. Recreational fishermen may be required to alter their fishing locations during dredging.

### 7.13.2 No-Action Alternative

The no-action alternative would result in a loss of recreation resources due to long-term erosion of usable beach.

## 7.14 Navigation

### 7.14.1 Preferred Alternative

Recreational boaters frequently use this area. Boating in the area of the dredge equipment will be restricted due to equipment and pipeline activities, but only temporarily while the beach is being renourished. Once the project has been completed, navigation will resume unhindered.

### 7.14.2 No-Action Alternative

There will be no affect on navigation with the no-action alternative.

## 7.15 Historic and Cultural Resources

### 7.15.1 Preferred Alternative

#### 7.15.1.1 Shoreline Operations Area

The shore-based operations area will have no effect on historic resources. In 2005 USACE consulted with the State Historic Preservation Officer (SHPO) regarding the initial development of the project and upon the recommendation of the SHPO and the Miccosukee Tribe of Florida, the shoreline area was surveyed for cultural resources (DHR letter # 2005-3337, Miccosukee Tribe letter dated 19 April 2005); a copy is included in **Appendix F**. The survey conducted by USACE did not identify any historic

properties within the immediate project foot print. USACE determined that the use of the shoreline area will have no effect on historic properties (DHR letter #2010-03935-C, THPO#006745); a copy is included in **Appendix F**. The preferred alternative will beneficially affect historic properties located immediately west of the project area. Material placed along the shoreline will serve as a protective buffer for the historic resources in the immediate vicinity.

#### 7.15.1.2 Nearshore Operations Area

Within the nearshore of the study area, a single target has been identified during a hardbottom survey. While additional archeological work will be needed to precisely map the location of the historic property, it is anticipated that no historic properties would be affected by any of the project alternatives in the nearshore. The identified resource will be properly buffered (minimum of 200 feet; see Table 7-1) to ensure required protection of the resource. Consultation with the SHPO and appropriate federally recognized tribes will occur prior to the project construction when additional work is completed.

#### 7.15.1.3 Offshore Borrow Area

It is anticipated that no historic properties would be affected by use of any of the proposed borrow areas. As part of the investigations of the proposed design of the borrow areas, a background and literature search revealed that there are currently no known historic properties within the proposed borrow areas. In a 2005 consultation with the SHPO, it was recommended that an underwater survey of the proposed borrow area be conducted. This survey will be conducted prior to project construction. If any resources are identified they will be properly buffered to ensure required protection of the resource. Borrow areas are sufficiently designed to provide space for required buffering without altering their size. While currently borrow area 2A is the main source, if volume is removed because of the identification of resources within the proposed borrow area, then additional borrow sources can be considered at borrow area 2B. Consultation with the SHPO and appropriate federally-recognized tribes is ongoing and will continue occur prior to project construction.

### 7.15.2 No-Action Alternative

#### 7.15.2.1 Shoreline Sand Operations Area

The no-action alternative does not directly impact historic resources but does allow for continued shoreline erosional forces. There are historic structures located between the highway and the shoreline. Subsequently, these structures will be vulnerable to both short-term effects from storm damage and long-term erosional forces that will eventually place these historic structures within reach of the ocean. If lost, the historic fabric of the coastal community will suffer.

#### 7.15.2.2 Nearshore Operations Area

There would be no effects on historic properties.

#### 7.15.2.3 Offshore Borrow Area

There would be no effects on historic properties.

### 7.16 Native Americans

No portion of this project affects Native American properties. Consultation with appropriate federally-recognized tribes has been ongoing since 2005 and will continue through project design. USACE has discussed this project with the Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida in regard to its Section 106 responsibilities under the National Historic Preservation Act (NHPA).

### 7.17 Natural or Depletable Resources

Sand is a natural and depleting resource. Using sand from the proposed borrow area, Borrow Area 2 (Sub-areas 2A, 2B, and 2C), will deplete the sand source at those sites. The sand will be depleted from the borrow areas, but will enter into the nearshore sand transport system. Although sand will eventually return to offshore areas and be redistributed over nearshore areas downdrift of the project, it is unlikely that the redistributed sand will be sufficient to refill the borrow area. This would result in depletion of mineral resources in the borrow areas.

### 7.18 Cumulative Impacts

Cumulative impacts are defined in 40 CFR 1508.7 as those effects that result from:

*...the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.*

**Table 7- 2** summarizes the impact of such cumulative actions by identifying the past, present, and reasonably foreseeable future condition (50 years) of the various resources which are directly or indirectly impacted by the proposed action and its alternatives. The table also illustrates the with-project and without-project condition (the difference being the incremental impact of the project). Also illustrated is the future condition with any reasonable alternatives (or range of alternatives).

As part of the evaluation of cumulative impacts pursuant to CEQ 1997 *Considering Cumulative Effects under the National Environmental Policy Act*, other actions affecting similar resources or ecosystem were considered. There are no other projects in the region that share a similar ecosystem that could have cumulative impacts on similar resources. In Northeast Florida, there are active beach nourishment projects in Nassau, Duval, and St. Johns Counties. All of these projects have separate sufficient sand resources identified, which will not be impacted by the proposed project. Beach nourishment projects located south of Cape Canaveral, in the southeast region of Florida, will not impact the borrow areas identified for the proposed project. The proposed project will not impact or be impacted by any inlet maintenance project within the region. The closest maintained inlets to the proposed project are the St. Augustine Inlet located approximately 33 miles north of the project area and Ponce inlet located approximately 29 miles south of the project area.



**Table 7- 2: Summary of Cumulative Effects**

	<b>Boundary (time and space)</b>	<b>Past (baseline condition)</b>	<b>Present (existing condition)</b>	<b>Future without project (No Action)</b>	<b>Future with Proposed Action</b>
Sand Resources	Pre- development to 2062, Flagler County	Offshore sand resources identified for this project have never been used for beach nourishment or other purposes	Sufficient offshore sand resources exist for all the beach nourishment projects in Northeast Florida including the proposed project	Offshore sand resources identified for this project will not likely be utilized for other shore protection activities in other areas of Florida	Offshore sand resources identified for this project will be reduced, but not depleted over the life of this project
Protected Species	Pre- development to 2062, Flagler County	More abundant and widespread	Individuals becoming increasingly rare; habitat shrinking	individuals are not acutely affected by dredging; however, beach habitat continues to shrink	Individuals may be affected by dredging and placement activities; habitat is sustained for life of project. Loss of private access cross-overs may impact dune from foot traffic through vegetation, and nesting areas for sea turtles and shorebirds.
Dune Vegetation	Pre- development to 2062, Flagler County	Abundant vegetative cover of appropriate dune species with moderate diversity	Areas of the shoreline have lost dune and associated vegetation from armoring. Existing dunes are subject to erosion resulting in loss of vegetation.	Areas containing vegetated dunes will continue to erode causing stress to plant species and lessen diversity	Reconstruction of dunes will stabilize the coastal ecosystem. Replanting with appropriate native species will increase diversity and improve overall dune habitat.
Water quality	Pre- development to 2062, Flagler County	Pristine	Increasingly degraded due to anthropogenic actions	no change to present condition	Temporary increases in local turbidity; no long-term change to degraded state
Socio-Economic	Pre- development to 2062, Flagler County	More abundant tourism and property values, fluctuating with national economy	Increasingly degraded beach has negative impact on tourism industry and property values.	Loss of revenue from decreased tourism. Property values decline. Boardwalk structures will become undermined and unstable.	Privately owned boardwalk cross-overs will be removed or buried. Easements will compensate property owners for replacement cost for private access to the beach

### 7.18.1 Sand Resources

Because sand resources at offshore sites are not replenished very quickly by natural forces, it is anticipated that the use of the borrow areas for the life of this project would result in the depletion of this sand supply. Dredging of the proposed borrow areas to construct the beach fill project would have temporary impacts on the benthic infaunal communities. If the borrow areas identified in this environmental assessment are not used for this project, the growing demand for sand to use in protecting Florida shorelines suggests that they would be utilized in the future by other stakeholders.

Sediment transport in the nearshore region is natural and continuous. However, cumulative beach nourishment and other anthropogenic activities can increase rates of nearshore sediment transport, exacerbating background levels and causing stress to nearshore benthic communities (Jordan, Banks et al. 2010). The proposed action would likely have minimal, temporary adverse impacts to EFH during each nourishment event over the life of the project. With the renourishment interval expected every eleven years, and the recovery time of the affected benthic community after sand removal anticipated to be within one to two years, the potential for significant cumulative benthic biological impacts is remote. No significant cumulative impacts on the pelagic environment, including zooplankton, fishes, sea turtles, and marine mammals, are expected from the use of the borrow areas.

### 7.18.2 Protected Species

Dredge equipment activities could possibly have an impact on manatees, sea turtles, and whales, but measures will be taken to prevent these impacts and they are not likely to have a cumulative adverse impact on these species. Long-term changes in beach characteristics such as sand color, grain size, etc. could affect the use of the beach by nesting sea turtles. Since the proposed project is not likely to affect protected species, with the exception of sea turtles, should a hopper dredge be utilized, the project would not contribute to adverse cumulative impacts on protected species. Through the ESA Section 7 consultation process, NMFS has determined that utilization of a hopper dredge is not likely to lead to the extinction of sea turtles, provided the reasonable and prudent measures and implementing terms and conditions are followed. The project would restore beach use by nesting sea turtles and migratory birds, which may result in a positive effect on the long-term populations of these species. Protected species would be periodically affected in a manner similar to that described in **Section 7.3** for each nourishment event through the life of the project.

### 7.18.3 Water Quality

Water quality impacts from the proposed action would be temporary in nature. There is some concern that sand movement from nourished beaches can cause increased turbidity in nearshore waters during large storm events. However, barrier islands are dynamic systems with constantly shifting sands. Erosion and accretion

of sands occurs naturally in these systems, creating localized turbidity during storm events and in the winter months (Jones and Mangun 2001). An increase in fine sediments following a nourishment event can result in increased turbidity causing a localized, short duration disturbance that generally last only as long as the dredging operations are taking place (Nightingale and Simenstad, 2001).

#### 7.18.4 Conclusion

Because sand resources appear to be replenished slowly, the proposed project provides an incremental effect on the depletion of offshore sand resources. The proposed project would not have significant adverse effects on protected species, EFH, or water quality due to protective conditions developed in coordination and consultation with the resource agencies. The proposed project would not provide any known incremental result that would contribute to adverse cumulative impacts of these biological resources.

### 7.19 Irreversible and Irretrievable Commitment of Resources

#### 7.19.1 Irreversible

An irreversible commitment of resources is one in which the ability to use and/or enjoy the resource is lost forever. One example of an irreversible commitment might be the mining of a mineral resource. The use of sand from the proposed borrow areas would, for all practical purposes, irreversibly deplete the suitable sand reserves. The sands would not replenish fast enough to be of much value to future nourishment projects.

#### 7.19.2 Irretrievable

An irretrievable commitment of resources is one in which, due to decisions to manage the resource for another purpose, opportunities to use or enjoy the resource as they presently exist are lost for a period of time. An example of an irretrievable loss might be where a type of vegetation is lost due to armoring. Environmental impacts caused by use of the borrow sites for placement on the dune and beach would be small since only a featureless, sandy bottom would be impacted.

### 7.20 Unavoidable Adverse Environmental Effects

Species of relatively non-motile infaunal invertebrates (aquatic animals that live in the substrate of a body of water, such as soft sea bottom) that inhabit the benthic zone of borrow areas and the immediate submerged beach placement site will unavoidably be lost during dredging. Those species that are not able to escape the construction area are expected to re-colonize after project completion.

### 7.21 Local Short-Term Uses and Maintenance/Enhancement of Long-Term Productivity

Species of motile epifaunal invertebrates (benthic animals that live on the substrate surface) may inhabit the borrow areas and placement site. Motile organisms such as fish, crabs, and sand dwelling organisms should be able to escape the area during construction. Many of those species that are not able to escape the construction area are expected to re-colonize after project completion.

### 7.22 Compatibility with Federal, State, and Local Objectives

The Preferred Alternative is compatible with Federal, state, and local objectives of protecting upland properties while maintaining a natural beach. It also provides the most cost-effective option for meeting these objectives. The no-action alternative does not meet the Federal, state, and local objectives.

### 7.23 Conflicts and Controversy

No conflicts or controversy regarding this project have been identified.

### 7.24 Uncertain, Unique, or Unknown Risks

The direct site-specific impacts of the Preferred Alternative and the no-action alternative can be predicted with a high degree of certainty; therefore, uncertainty is minimized. However, predictions of cumulative and indirect impacts are, to a degree, inherently uncertain. This project is based on the best available scientific and engineering information, and although no significant adverse impacts are expected, a low probability is always present. The project design is not unique; thus, it should not create unique risks.

### 7.25 Precedent and Principle for Future Actions

This project would not establish a precedent for future actions with significant effects or represent a decision in principle for future considerations.

### 7.26 Environmental Commitments

USACE and its contractors commit to avoiding, minimizing, or mitigating for adverse effects during construction activities. Adequate buffers were established during the borrow site design to ensure that no impacts on resources occur. Environmental commitments resulting from agency comments, public concern, laws and regulations, and permit requirements will be included in the contract specifications.

### 7.26.1 Protection of Fish and Wildlife Resources

The contractor shall keep construction activities under surveillance, management, and control to minimize interference with, disturbance to, and damage of fish and wildlife. Species that require specific attention along with measures for their protection shall be listed in the Contractor's Environmental Protection Plan prior to the beginning of construction operations.

Dredging will not occur within 400 feet of any known significant hardbottom areas. This project is not anticipated to result in hardbottom impacts.

### 7.26.2 Endangered species protection

USACE will comply with all requirements of any consultation documents associated with this project provided under the Endangered Species Act from either USFWS or NMFS. Buffers will be maintained for any known significant hardbottom areas or structures that serve as attractants to sea turtles for foraging or shelter. These buffers and any other turtle safety precautions would be maintained to comply with the NMFS SARBO. If a hopper dredge is used for the dredging operations, potential impacts to sea turtles could occur. To minimize the risk to sea turtles, standard sea turtle protection conditions will be implemented such as the use of a state-of-the-art rigid deflector draghead at all times, inflow screens, and/or monitoring of the operation.

### 7.26.3 Water Quality

The USACE contractor will prevent oil, fuel, or other hazardous substances from entering the air or water. This will be accomplished by design and procedural controls. All wastes and refuse generated by project construction would be removed and properly disposed. The USACE contractor will implement a spill contingency plan for hazardous, toxic, or petroleum material for the borrow area. Compliance with U.S. EPA Vessel General Permits would be ensured, as applicable. USACE will secure a Section 401 Water Quality Certification prior to construction.

### 7.27 Dredge and Borrow Area Monitoring Requirements

Electronic positioning information, production, and volume data would be collected. Pre- and post-dredging hydrographic surveys will be conducted to monitor physical changes in the borrow area. The dredge would be equipped with an on-board global positioning system capable of maintaining or recording the location of the dredge, drag arms, and/or cutterhead.

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## 7.28 Compliance with Environmental Requirements

### 7.28.1 National Environmental Policy Act of 1969

Environmental information on the project has been compiled and this Environmental Assessment has been prepared. At this time, USACE is not proceeding with an Environmental Impact Statement. Final compliance with the National Environmental Policy Act will occur with the signing of a Finding of No Significant Impact (FONSI). The project is in compliance with this Act. For a feasibility study and certain other actions, a 30-day comment period is required.

### 7.28.2 Endangered Species Act of 1973

This project falls under the scope of the USFWS Statewide Programmatic Biological Opinion for Shore Protection Activities along the Coast of Florida (SPBO; issued 18 April, 2011, and modified 22 August, 2011). USACE will adhere to the terms and conditions outlined in that document for projects including sand placement from beach nourishment activities primarily for shore protection. USACE coordinated with USFWS pursuant to the SPBO on 1 November 2011. Although no piping plover wintering population critical habitat is present within the study area or the project limits, individuals have been observed on the shoreline south of the project limit (ending at FDEP monument R-95) at the Gamble Rodgers Memorial State Recreation Area (located at R-98). Additional coordination with the USFWS was conducted as part of the action. The required SPBO 30-day notification letter was submitted on 3 October 2013 to the USFWS and included a Piping Plover Programmatic Biological Opinion Survey; see the **Environmental Appendix** for copies of these documents. Correspondence from USFWS dated May 30, 2014 was received on June 5, 2014 which stated “This letter fulfills the requirements of the Act and no further action is required.” A copy of the letter is included in **Appendix F**.

Critical habitat designation is proposed for loggerhead that would affect operations. Terms and Conditions with respect to loggerhead in the current SARBO will be employed at this time. New SARBO update consultation between USACE and NMFS is addressing the issue of critical habitat designation for loggerhead along with other issues in the proposed SARBO revision. SPBO will require updating once the proposed critical habitat is finalized. FWS has proposed areas of critical habitat for shoreline nesting. Future renourishment events may require updated consultation with respect to the FWS SPBO and NMFS SARBO once the critical habitat is finally established.

This project also falls under the scope of the NMFS South Atlantic Regional Biological Opinion (SARBO; issued 25 November, 1991, as amended in 1995 and 1997). The SARBO requires a 400-foot buffer surrounding significant hardbottom resources. For the purposes of the SARBO, a significant hardbottom is “one that, over a horizontal distance of 150 feet, has an average elevation above the sand of

1.5 feet or greater, and has algae growing on it.” The study conducted by Dial Cordy and Associates, Inc., in 2011, and further explored with the USACE survey of 2012, did not identify any hardbottom habitats that met this definition within the project action limits. Additionally, no hardbottom resources were found in the proposed borrow areas. Therefore, the 400-foot buffer requirement is not applicable to the three borrow areas considered in this environmental assessment. However, the borrow areas will include a 400-foot buffer around any hardbottoms identified during operations as a precautionary measure to avoid impacts to these habitats if they are encountered.

This project was fully coordinated under the Endangered Species Act of 1973, as amended, 16 U.S.C. 1531, *et seq.*, P.L. 93-205, and is in full compliance with this Act.

#### 7.28.3 Fish and Wildlife Coordination Act of 1958

USACE has and will continue to maintain continuous coordination with the USFWS during all stages of the planning and construction process. USACE consulted with the USFWS pursuant to the FWCA, NEPA, and the ESA. This project is in full compliance with the Act. Correspondence from USFWS dated May 30, 2014 was received on June 5, 2014 which addressed compliance with the FWCA. A copy of the letter is included in **Appendix F**.

#### 7.28.4 National Historic Preservation Act of 1966

Consultation with the Florida State Historic Preservation Officer (SHPO) is ongoing in accordance with the National Historic Preservation Act (NHPA) of 1966, as amended, and as part of the requirements and consultation processes contained within the NHPA implementing regulations of 36 CFR 800, this project is also in compliance with the Archeological Resources Protection Act (96-95), Native American Graves Protection Act (PL 101-601), American Indian Religious Freedom Act (PL 95-341), Executive Orders (E.O) 11593, 13007, & 13175 and the Presidential Memo of 1994 on Government to Government Relations. In a letter dated 28 February 2012, the SHPO concurred with the USACE finding of no historic properties use of the shoreline. Consultation related to nearshore and borrow areas are ongoing. The current project has been briefed to the Miccosukee Tribe of Indians of Florida and the Seminole Tribe of Florida as part of the district’s annual face-to-face meetings on cultural resources that have been occurring since 2010. No comments have been received during these ongoing annual meetings. Additional cultural resource survey and consultation with the SHPO and appropriate federally-recognized tribes will be needed for areas within the nearshore and borrow areas. Consultation is ongoing.

#### 7.28.5 Clean Water Act of 1972

A Joint Coastal Permit (JCP) application for shore protection along the Flagler County HSDR project area will be prepared and submitted by USACE upon completion of the feasibility phase of the project. Final compliance with the Clean Water Act will occur when this Water Quality Certification is received from the State of Florida. All State water quality standards would be met. A Section 404(b) evaluation is included in **Appendix F**. The project is in compliance with this Act.

#### 7.28.6 Clean Air Act of 1972

No air quality permits would be required for this project. This environmental assessment will be coordinated with the U.S. Environmental Protection Agency (EPA) and is in compliance with Section 309 of the Act. Any correspondence received from the EPA will be included in **Appendix F** of the final environmental assessment, and a discussion of any issues they raise will be included in the Public and Agency Involvement section of the final environmental assessment.

#### 7.28.7 Coastal Zone Management Act of 1972

A Federal consistency determination in accordance with 15 CFR 930 Subpart C is included in this report as **Appendix F**. State consistency review was performed during the coordination of the draft environmental assessment. The FDEP commented that they “concur the project is consistent with the state statutory authorities at this stage. The state’s final coastal zone consistency finding will occur at the completion of the engineering and design phase when the items needed to complete the state’s permitting of the project are available.” A copy of the FDEP comment is included in **Appendix G – Pertinent Correspondence**.

#### 7.28.8 Farmland Protection Policy Act of 1981

No prime or unique farmland would be impacted by implementation of this project. This act is not applicable.

#### 7.28.9 Wild and Scenic River Act of 1968

No designated Wild and Scenic River reaches would be affected by project related activities. This act is not applicable.

#### 7.28.10 Marine Mammal Protection Act of 1972

The project will not adversely affect marine mammal species. Incorporation of safeguards to protect threatened and endangered species during project construction would also protect marine mammals in the area. Therefore, this project is in compliance with this act.



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#### 7.28.11 Estuary Protection Act of 1968

No designated estuary would be affected by project activities. This act is not applicable.

#### 7.28.12 Federal Water Project Recreation Act

The principles of the Federal Water Project Recreation Act, (Public Law 89-72) as amended, have been fulfilled by complying with the recreation cost-sharing criteria. Another area of compliance includes the public beach access requirement on which the renourishment project depends, as described in **Chapter 2** pursuant to USACE ER 1105-2-100 and ER 1105-2-130.

#### 7.28.13 Submerged Lands Act of 1953

The project would occur on submerged lands of the State of Florida. The project will be coordinated with the state and is in compliance with the act.

#### 7.28.14 Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990

The Coastal Barrier Resources Act (CBRA) and the Coastal Barrier Improvement Act of 1990 (CBIA) limit federally-subsidized development within CBRA Units to limit the loss of human life by discouraging development in high-risk areas; to reduce wasteful expenditures of Federal resources; and to protect the natural resources associated with coastal barriers. CBRA provides development goals for undeveloped coastal property held in public ownership, including wildlife refuges, parks, and other lands set aside for conservation known as “otherwise protected areas” (OPAs). These public lands are excluded from most of the CBRA restrictions, although they are prohibited from receiving Federal Flood Insurance for new structures.

Federal monies can be spent within CBRA units for certain activities, including (1) projects for the study, management, protection, and enhancement of fish and wildlife resources and habitats; (2) establishment of navigation aids; (3) projects funded under the Land and Water Conservation Fund Act of 1965; (4) scientific research; (5) assistance for emergency actions essential to saving lives and the protection of property and the public health and safety, if preferred pursuant to the Disaster Relief Emergency Assistance Act and the National Flood Insurance Act and are necessary to alleviate the emergency; (6) maintenance, repair, or reconstruction, but not expansion, of publically-owned or publically-operated roads, structures, or facilities; (7) nonstructural projects for shoreline stabilization that are designed to mimic, enhance, or restore a natural stabilization system; (8) any use or facility necessary for the exploration, extraction, or transportation of energy resources; (9) maintenance or construction of improvements of existing Federal navigation

channels, including the disposal of dredge materials related to such projects; and (10) military activities essential to national security.

There are two CBRA OPAs in the project vicinity Unit FL-06P, Washington Oaks Garden State Park, or Unit FL-P07P, Gamble Rodgers Memorial State Recreation Area (see Chapter 2). Although these areas fall within the study area, they are otherwise protected and are not subject to the same restrictions as a “coastal barrier resource unit.” Furthermore, they occur outside of the project limits for any proposed shoreline protection activities. The proposed project does not include the construction of structures that would require Federal Flood Insurance in any areas designated as pursuant to the CBRA; therefore, Federal expenditures for the proposed project are not restricted in these OPA areas. The activities proposed in the remainder of the CBRA units in the project area are consistent with the intent of the Act. The project is in compliance with the Act.

#### 7.28.15 Rivers and Harbors Act of 1899

The proposed work would not obstruct navigable waters of the United States. The proposed action will be subject to the public notice, public hearing, and other evaluations normally conducted for activities subject to the act. The project is in full compliance.

#### 7.28.16 Anadromous Fish Conservation Act

Anadromous fish species would not be affected. This environmental assessment will be coordinated with NMFS. This project is in compliance with the act.

#### 7.28.17 Migratory Bird Treaty Act and Migratory Bird Conservation Act

Migratory birds would be minimally affected by dredging in the borrow areas. USACE will include our standard migratory bird protection requirements in the project plans and specifications and will require the contractor to abide by those requirements. Dune and beach construction activities at the placement site will be monitored at dawn or dusk daily during the nesting season to protect nesting migratory birds. If nesting activities occur within the construction area, appropriate buffers will be placed around nests to ensure their protection. The project is in compliance with these acts.

#### 7.28.18 Marine Protection, Research and Sanctuaries Act

The term "dumping" as defined in the Act (3[33 U.S.C. 1402](f)) does not apply to the disposal of material for dune and beach nourishment, or to the placement of material for a purpose other than disposal (i.e., placement of rock material as an artificial reef or the construction of artificial reefs as mitigation). Therefore, the Marine Protection, Research and Sanctuaries Act does not apply to this project. The

disposal activities addressed in this EA have been evaluated under Section 404 of the Clean Water Act (see **Appendix F**).

#### 7.28.19 Magnuson-Stevens Fishery Conservation and Management Act

This act requires preparation of an EFH Assessment and coordination with NMFS. This document serves as this assessment, and includes these required elements: (1) a description of the proposed action (see **Section 5**); (2) analysis of individual and cumulative effects on EFH, federally managed fisheries, and associated species such as major prey species, including affected life history stages (see **Sections 2.4.6 and 7.6**); and (3) USACE Jacksonville District's view regarding effects (see **Section 7.6**). Correspondence from NMFS with regards to EFH dated June 11, 2014 addressed compliance with the Act. A copy of the letter is included in **Appendix F**. This project is in compliance with the Act.

#### 7.28.20 Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970

The purpose of PL 91-646 is to ensure that owners of real property to be acquired for Federal and federally-assisted projects are treated fairly and consistently and that persons displaced as a direct result of such acquisition will not suffer disproportionate injuries as a result of projects designed for the benefit of the public as a whole.

This project does not involve displacement of property owners or tenants. The project involves real property acquisition in the form of easements. Acquisition will be in compliance with PL 91-646.

#### 7.28.21 E.O. 11990, Protection of Wetlands

No wetlands would be affected by project activities. This project is in compliance with the goals of this Executive Order.

#### 7.28.22 E.O. 11988, Flood Plain Management

Under Section 102(2) (C) of the NEPA, the project limits are within a mapped flood hazard zone as determined by the Department of Housing and Urban Development floodplain mapping. The proposed Federal action of implementing this project will not significantly, adversely affect the quality of the human environment, but may in fact, benefit the environment. Although the area is within a coastal flood-prone area, the purpose of the project is to provide better protection for human health and safety. Design of the proposed action will minimize potential harm from storm events that result in flood impacts. No other development will occur as a result of the project. Therefore, this project is in compliance with the goals of this Executive Order.

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#### 7.28.23 E.O. 12898, Environmental Justice

This action would not result in adverse human health or environmental effects that would be disproportionately higher towards minority or low-income populations. The activities will not affect subsistence consumption of fish and wildlife. This project is in compliance with the goals of this Executive Order.

#### 7.28.24 E.O. 13089, Coral Reef Protection

This Executive Order refers to "those species, habitats, and other natural resources associated with coral reefs." This project will not affect U.S. coral reef ecosystems as defined by this Executive Order. Precautions would be implemented during construction to minimize impacts.

#### 7.28.25 E.O. 13112, Invasive Species

The proposed action will require the mobilization of dredge equipment from other geographical regions. Dredge equipment has the potential to transport species from one region to another, introducing them to new habitats where they are able to out-compete native species. The benefits of the proposed project outweigh the risks associated with the very slight potential for introducing non-native species to this region. The action takes place solely in ocean waters, minimizing risk to more sheltered coastal habitats. This environmental assessment will be coordinated with the Invasive Species Council, and is consistent with the Florida Invasive Species Strategic Plan.

#### 7.28.26 E.O. 13186, Migratory Birds

This Executive Order requires, among other things, a Memorandum of Understanding (MOU) between the Federal Agency and the USFWS concerning migratory birds. No final MOU exists between USACE and the USFWS pursuant to this Executive Order; however, there is an MOU between the Department of Defense and the USFWS, and there is a draft MOU between USACE and the USFWS. Neither the Department of Defense MOU nor the USACE Draft MOU clearly address migratory birds on lands not owned or controlled by USACE, as is the case with the project area. For many USACE civil works projects, the real estate interests are provided by the non-federal sponsor. Control and ownership of the project lands remain with a non-federal interest. USACE will include our standard migratory bird protection requirements in the project plans and specifications and will require the contractor to abide by those requirements. Measures to avoid the destruction of migratory birds and their eggs or hatchlings are described in the section above on the Migratory Bird Treaty Act.

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#### 7.28.27 E.O. 13045, Protection of Children

A growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's neurological, immunological, digestive, and other bodily systems are still developing; children eat more food, drink more fluids, and breathe more air in proportion to their body weight than adults; children's size and weight may diminish their protection from standard safety features; and children's behavior patterns may make them more susceptible to accidents because they are less able to protect themselves. This Executive Order requires Federal agencies to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children.

This project will not negatively impact the food supplies, drinking water, or air quality to which children are exposed. The construction site will be hazardous to children, but the project specifications include a number of protocols intended to designate the project area as a work area and prevent non-authorized personnel from entering the site. These protocols include the installation of orange safety fencing and danger signs, functioning back-up warning signals on all construction equipment, and providing site security when on-site construction activities have temporarily ceased. The project specifications also require contractors to adhere to the provisions outlined in USACE EM 385-1-1 (15 September 2008).

# CHAPTER 8

## PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

POSTER PRESENTED AT PUBLIC SCOPING MEETING IN FLAGLER COUNTY

### STUDY OVERVIEW

**FLAGLER COUNTY HURRICANE AND STORM DAMAGE REDUCTION FEASIBILITY STUDY AND ENVIRONMENTAL IMPACT STATEMENT**

**GOAL**  
Reduce damages caused by erosion and coastal storms to coastal infrastructure along the Flagler County shoreline.

**OBJECTIVES**

- Reduce storm damage to coastal infrastructure
- Maintain opportunities for recreational use of beach and nearshore areas
- Maintain environmental quality and integrity

**PUBLIC PARTICIPATION**  
The study is in the plan formulation phase. Your continued input is important.

**PARTICIPATE TODAY**

Please assist us in identifying community-specific issues relative to the Flagler County Hurricane and Storm Damage Reduction Study by providing us with your comments. Every comment will be considered and will help us continue to make informed decisions as we finalize the project planning process.

Comments may be submitted:

1. Using a comment sheet provided here today.
2. Electronically entering them at: [FlaglerHSDR.Comments.usace.army.mil](http://FlaglerHSDR.Comments.usace.army.mil)
3. Writing and mailing them to:  
U.S. Army Corps of Engineers,  
Jacksonville District,  
P.O. Box 4970,  
Jacksonville, FL 32232-0019  
Attention: Kathleen McConnell

**CORPS CIVIL WORKS PROCESS & STUDY TIMELINE**

**PROBLEM IDENTIFICATION**  
MAY 2007: The authority for conducting the study is contained in House Resolution 2676

**RECONNAISSANCE STUDY**  
MAR 2004: Reconnaissance Report indicates Federal interest in conducting a Feasibility Study

**FEASIBILITY STUDY (with integrated NEPA)**  
SEPT 2004: Feasibility Cost Sharing Agreement (FCSA) executed  
2008: Feasibility Study initiated and scoping letter sent to local residents and agencies  
2014: Feasibility Study completed and approved

**PROJECT AUTHORIZATION AND APPROPRIATIONS**  
2016: Project Authorized by Congress in a Water Resources Development Act (WRDA) Bill  
2016: Appropriations Granted in an Energy & Water Development Bill

**PROJECT CONSTRUCTION**  
2017: Initial Project Construction

**SIX STEP PLANNING PROCESS**

- Specify Problems and Opportunities
- Inventory and Forecast Conditions
- Formulate Alternative Plans
- Evaluate Effects of Alternative Plans
- Compare Alternative Plans
- Select Recommended Plan

### FLAGLER COUNTY FLORIDA HURRICANE & STORM DAMAGE REDUCTION STUDY

**MARINELAND**  
0.6 MILES

**PAINTERS HILL**  
1.9 MILES

**BEVERLY BEACH**  
1.2 MILES

**FLAGLER BEACH**  
6.4 MILES

U.S. ARMY CORPS OF ENGINEERS | Jacksonville District

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FLAGLER COUNTY, FLORIDA  
HURRICANE AND STORM DAMAGE REDUCTION PROJECT  
FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

**CHAPTER 8**  
**PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION**

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## 8 PUBLIC INVOLVEMENT, REVIEW AND CONSULTATION

### 8.1 Public Involvement Program

The public involvement program included the following items to contact or directly involve the public in the planning process by: sending a scoping letter to interested parties, conducting a public scoping meeting, sending a Notice of Availability on the draft report to interested parties, and holding a public workshop in order to obtain comment on the draft report.

### 8.2 Agency Involvement

A feasibility scoping meeting (FSM) was held by the Jacksonville District Planning Division staff to discuss the study on January 28, 2011. The purpose of the FSM was to collect input from affected resource agencies by discussion of:

- The “Future Without Project” anticipated conditions in the study area
- Related issues on the affect to resources for moving the study forward, with specific reference to the alternatives identified in the Draft Feasibility Study Report and integrated National Environmental Policy Act (NEPA) document
- Focus on the feasibility study tailored to the key alternatives
- Further definition of the required depth of analysis, as well as defined study constraints.

Either physical or virtual (via phone conferencing and webinar) attendance at the FSM included representation from the following agencies:

- U.S. Army Corps of Engineers (USACE) Headquarters (HQ), South Atlantic Division (SAD), and Jacksonville District (SAJ)
- Flagler County (Project Sponsor)
- City of Flagler Beach
- Florida Department of Environmental Protection (FDEP)
- Florida Department of Transportation (FDOT)
- Bureau of Ocean Energy Management, Regulation, and Enforcement (a.k.a. BOEM)
- Florida Fish and Wildlife Conservation Commission (FWC)

In addition to those listed above, an invitation to attend the event also included the following agencies:

- U.S. Fish and Wildlife Service (USFWS)
- National Marine Fisheries Service (NMFS)
- U.S. Environmental Protection Agency (EPA)

A study overview presentation was provided by the SAJ District via a web-meeting. The sponsor and agencies provided their comments and input on the study, and the important issues identified from the USACE HQ Office of Water Project Review (OWPR) comments were discussed in detail.

### 8.3 Required Coordination

#### 8.3.1 Outer Continental Shelf Lands Act (OCSLA)

Under Section 8(k) of the Outer Continental Shelf Lands Act (OCSLA), dredging of sediment resources within the OCS requires authorization by the Bureau of Ocean Energy Management (BOEM) for use during initial or maintenance construction or both. The BOEM Leasing Division is charged with environmentally responsible management of Federal OCS sand and gravel resources. P.L. 102-426 [43 United States Code (U.S.C.) 1337(k)(2)], enacted October 31, 1994, gave BOEM the authority to negotiate, on a noncompetitive basis, the rights to OCS sand, gravel, and shell resources for CSDR projects; beach or wetlands restoration projects; or for use in construction projects funded in whole or part by or authorized by the Federal government. Recognizing that identified borrow areas are within the OCS, BOEM has agreed to serve as a cooperating Federal agency on this study and may undertake a connected action (i.e., authorize use of the OCS borrow area) that is related to, but unique from the USACE proposed action. BOEM's proposed action is to issue a negotiated agreement pursuant to its authority under the OCSLA.

#### 8.3.2 USFWS and NMFS: Endangered Species Act (ESA) - Section 7 Consultation

This project falls under the scope of the USFWS Statewide Programmatic Biological Opinion for Shore Protection Activities along the Coast of Florida (SPBO; issued April 18, 2011, and modified August 22, 2011). USACE coordinated with USFWS pursuant to the SPBO on November 1, 2011 (see **Appendix F**). Continued coordination with the USFWS will be conducted as part of the action.

This project also falls under the scope of the NMFS South Atlantic Regional Biological Opinion (SARBO; issued November 25, 1991, as amended in 1995 and 1997). The SARBO covers the proposed action of BOEM to issue a negotiated

agreement pursuant to its authority under the Outer Continental Shelf Lands Act (OCSLA) for uses of the OCS borrow area.

### 8.3.3 USFWS: Fish and Wildlife Coordination Act (FWCA)

USACE has and will continue to maintain continuous coordination with the USFWS during all stages of the planning and construction process. USACE consulted with the USFWS pursuant to the FWCA, NEPA, and the ESA. USACE is coordinating with the USFWS concerning compliance with the Fish and Wildlife Coordination Act. Given the limited impacts of this project, USACE is seeking agreement from the USFWS that the requirements of the act would be met through the NEPA coordination and Section 7 ESA consultation process.

### 8.3.4 NMFS: Magnuson-Stevens Fishery Conservation and Management Act

The NEPA portion of this integrated document serves as the Essential Fish Habitat (EFH) assessment, and includes these required elements: (1) a description of the proposed action; (2) analysis of individual and cumulative effects on EFH, federally managed fisheries, and associated species such as major prey species, including affected life history stages; and (3) SAJ's view regarding effects. Comments received from the NMFS as a result of USACE coordination and incorporated EFH Assessment will be included in the final environmental assessment once they are received. As a cooperating agency, BOEM will have a participating role in the EFH consultation.

### 8.3.5 Florida Department of Environmental Protection: Clean Water Act

Final compliance with the Clean Water Act will occur when the FDEP Water Quality Certification (WQC) is issued by the State of Florida. All State water quality standards would be met pursuant to all conditions of the WQC. Section 404 (a) requires a public notice with opportunity to request a public hearing for the proposed discharge of dredged or fill material into wetlands or other waters of the U. S. (ER 1105-2-100, Appendix C, part C-6.f). A Section 404(b) evaluation is included in this report in **Appendix F**.

### 8.3.6 State Historic Preservation Officer: National Historic Preservation Act (NHPA)

Consultation with the Florida State Historic Preservation Officer (SHPO) is ongoing in accordance with the National Historic Preservation Act of 1966, as amended, and as part of the requirements and consultation processes contained within the NHPA implementing regulations of 36 CFR 800. In a letter dated February 28, 2012, SHPO concurred with the USACE finding of no historic properties for use of the shoreline. This project is also in consultation with respect to the Archeological Resources

Protection Act (96-95), Native American Graves Protection Act (PL 101-601, American Indian Religious Freedom Act (PL 95-341), Executive Orders (E.O) 11593, 13007, & 13175, and the Presidential Memo of 1994 on Government to Government Relations. The current project has been briefed to the Miccosukee Tribe of Indians of Florida and the Seminole Tribe of Florida as part of the district's annual face-to-face meetings on cultural resources that have been occurring since 2010. Additional cultural resource survey and consultation with the SHPO and appropriate federally-recognized tribes will be needed for areas within the borrow areas and nearshore. Consultation related to the borrow area is ongoing.

### 8.3.7 National Environmental Policy Act

Pursuant to part 11 of ER 200-2-2 and 40 CFR 1501.4(e), a Finding of no Significant Impact (FONSI) is subject to a Notice of Availability. For a feasibility study and certain other actions, a 30-day comment period is required.

The draft EA and FONSI was circulated for a minimum 30-day review on January 17, 2014 to concerned agencies, organizations, and interested parties. Comments and responses received in response to the 30-day review are noted in **Appendix G**.

## 8.4 Scoping

### 8.4.1 Scoping Letter

In formulation and evaluation of the project, specific input from environmental agencies and the public were solicited through numerous means, including the following:

- A scoping letter was mailed to all Federal, state, and local agencies; local libraries; and all abutting property owners on August 26, 2008.
- A Notice of Intent to prepare a Draft Environmental Impact Statement was published in the Federal Register on August 26, 2008.

### 8.4.2 Public Scoping Meeting

A public scoping meeting was held in Bunnell, Flagler County, Florida on October 25, 2011 in fulfillment of NEPA requirements at which several viewpoints were presented including those for and against a coastal storm damage reduction project.

The following issues were identified to be relevant to the proposed action and appropriate for detailed evaluation:

- Vegetation
- Threatened and endangered species
- Fish and wildlife resources
- Essential fish habitat
- Coastal barrier resources
- Water quality
- Air quality
- Noise
- Aesthetic resources
- Recreation resources;
- Navigation
- Historic and cultural resources
- Native Americans
- Socio-economics
- Public safety

As mentioned in Section 8.2, a Feasibility Scoping Meeting (FSM) was held by the SAJ District Planning Division staff to discuss the study on January 28, 2011. A study overview presentation was provided by the SAJ District via web-meeting. The sponsor and various resource agencies provided their comments and input on the study, and the important issues identified from the USACE HQ Office of Water Project Review (OWPR) comments were discussed in detail.

#### 8.5 Notice of Availability (NOA) of Draft Environmental Assessment (EA)

Notification of the Draft Integrated Feasibility Study and Environmental Assessment for public review and comment was issued on January 17, 2014.

##### 8.5.1 Public Workshop on Draft Environmental Assessment (EA)

A public workshop on the Draft Integrated Feasibility Study and Environmental Assessment was held in Bunnell, Florida on February 5, 2014 from 6pm to 8pm. The recorded transcripts from this meeting can be found in **Appendix G**.

##### 8.5.2 Comments on the Draft Environmental Assessment (EA) from the General Public

The original 30-day comment period was extended at the request of several members of the public, and comments and questions were received from January 17, 2014 through March 15, 2014. All of the comments and questions along with a

summary table that includes responses can be found in **Appendix G**. Most of the comments were opposed to the project and to the study in general while only a couple of comments received were in support of the project.

### 8.5.3 Comments on the Draft Environmental Assessment (EA) from Agencies

Comments and questions on the Draft Integrated Feasibility Study and Environmental Assessment from the invested resource agencies in response to the notice of availability (NOA) were received from January 17, 2014 through March 15, 2014. The Bureau of Ocean Energy Management (BOEM) was the only Federal agency to submit comments. Comments were received from state agencies including the Florida Fish and Wildlife Conservation Commission (FWC), the Florida Department of Environmental Protection (FDEP), and the Florida Department of Transportation (FDOT). All of the agency comments are included in **Appendix G**. None of the agencies that commented were in opposition to the project.

### 8.6 Mailing List of Recipients

A complete and specific mailing list of recipients is included in **Appendix F**.

# CHAPTER 9

## RECOMMENDATIONS



FLAGLER COUNTY, FLORIDA  
HURRICANE AND STORM DAMAGE REDUCTION PROJECT  
FINAL INTEGRATED FEASIBILITY STUDY AND  
ENVIRONMENTAL ASSESSMENT

**CHAPTER 9**  
**RECOMMENDATIONS**



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## 9 RECOMMENDATIONS

I have given consideration to all significant aspects in the overall public interest including engineering feasibility, economic, social, cost and risk analysis, and environmental effects. The Recommended Plan described in this final report provides the optimum solution for shore protection benefits within the study area that can be developed with the framework of the formulation concepts. Implementation of the Hurricane and Storm Damage Reduction (HSDR) project for Flagler County, Florida is recommended at this time, with such modification as in the discretion of the Commander, Headquarters, U.S. Army Corps of Engineers (HQUSACE), may seem advisable.

The identified Recommended Plan is the National Economic Development (NED) plan, consisting of a ten-foot dune extension including a 10-foot sacrificial berm in Reach C, between FDEP R-monuments R80 and R94 in central Flagler Beach. The Recommended Plan covers 2.6 miles of shoreline length and mainly prevents damage to SR A1A. In addition to the NED benefits associated with reducing damages to infrastructure, the recommended plan will also have non-monetary benefits for environmental quality and other social effects.

Construction of the identified Recommended Plan will use a sand borrow source located seven miles offshore of the project site in territorial waters. The identified plan will most likely be constructed with a dredge and land based equipment typically used for beach nourishment projects. Initial construction will require approximately 415,800 cubic yards of sand from the borrow area (330,000 cubic yards for placement), and each periodic nourishment event will require approximately 403,000 cubic yards from the borrow area (320,000 cubic yards for placement). The renourishment interval is expected to be approximately 11 years, equaling 4 renourishment events in addition to initial construction over the 50-year period of Federal participation.

### 9.1 Draft Items of Local Cooperation

Recommendations for provision of Federal participation in the Recommended Plan described in this report would require the project sponsor to enter into a written Project Partnership Agreement (PPA), as required by Section 221 of Public Law 91-611, as amended, to provide local cooperation satisfactory to the Secretary of the Army. Such local cooperation shall provide the following non-federal responsibilities:

- a. Provide 35 percent of initial project costs assigned to hurricane and storm damage reduction, plus 50 percent of initial project costs assigned to protecting public park lands, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits; and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction, plus 100 percent of periodic nourishment costs

assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and as further specified below:

(1) Enter into an agreement that provides, prior to construction, 35 percent of design costs;

(2) Provide all lands, easements, and rights-of-way, and perform or ensure the performance of any relocations determined by the Federal Government to be necessary for the initial construction, periodic nourishment, and operation and maintenance of the project; in particular, the Federal Government and the project sponsor shall coordinate with the Bureau of Ocean Energy Management (BOEM) for use of offshore borrow areas and provide a copy of the lease agreement to the Federal Government;

(3) Provide, during construction, any additional amounts as are necessary to make their total contribution equal to 35 percent of initial project costs assigned to hurricane and storm damage reduction, plus 50 percent of initial project costs assigned to protecting public park lands, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits; and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction, plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

b. For so long as the project remains authorized, operate, maintain, and repair the completed project, or functional portion of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations, and any specific directions prescribed by the Federal Government;

c. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the non-federal sponsor of responsibility to meet the non-federal sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

d. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, mitigation, operation, maintenance, repair, replacement, and rehabilitation of the project and any project related betterments, except for damages due to the fault or negligence of the United States or its contractors;

e. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project in accordance with the standards for financial management systems set forth in the Uniform

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Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

f. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-federal sponsor with prior specific written direction, in which case the non-federal sponsor shall perform such investigations in accordance with such written direction;

g. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;

h. Agree that the non-federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

i. If applicable, comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

j. Comply with all applicable Federal and state laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*)), the Contract

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Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

k. Provide the non-federal share of that portion of the costs of data recovery activities associated with historic preservation, that are in excess of 1% of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;

l. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

m. Do not use Federal funds to meet the non-federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized;

n. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder future periodic nourishment and/or the operation and maintenance of the project;

o. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

p. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain, and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

q. For so long as the project remains authorized, the non-federal sponsor shall ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

r. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

s. Recognize and support the requirements of Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

t. At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the Federal Government; and

u. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires the non-federal sponsor to participate in and comply with applicable Federal floodplain management and

flood insurance programs, prepare a floodplain management plan within one year after the date of signing the project partnership agreement (PPA), and implement the plan no later than one year after project construction is complete.

## 9.2 Disclaimer

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to higher authority as proposals for project modification and/or implementation funding. The recommendations herein for provision of a hurricane and storm damage reduction project for Flagler County, Florida, do not include any provisions for work which would result in any new Federal expenditures or financial assistance prohibited by the Coastal Barrier Resources Act (Public Law 97-348); nor were funds obligated in past years for this project for purposes prohibited by this Act.

## 9.3 Certification of Public Accessibility

As part of the obligations established in the project partnership agreement (PPA) for the Flagler County, Florida, Hurricane and Storm Damage Reduction (HSDR) Project, the non-federal sponsor shall assure continued conditions of public ownership and public use of the shore upon which Federal participation is based during the economic life of the project. The non-federal sponsor shall also provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms. In the determination of the Federal interest in cost sharing, Federal participation was limited to areas where adequate parking and access are available. For shoreline reaches farther than  $\frac{1}{4}$  mile from public parking and/or beach access points, Federal participation was not provided. The maximum Federal participation allowable for each land use category is applied for cost sharing. I therefore conclude that there is reasonable public availability of the project beaches in all areas where Federal participation is provided.

Alan M. Dodd  
Colonel, U.S. Army  
District Engineer

# CHAPTER 10

## LIST OF PREPARERS



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## **10 LIST OF PREPARERS**

### 10.1 Preparers

#### Project Delivery Team

Martin Durkin, USACE, Plan Formulation

Lori Hadley, USACE, Coastal Engineering

Idris Dobbs, USACE, Economics

Colin Rawls, USACE, Economics

Jennifer Tyler, USACE, Cost Engineering

Kat McConnell, USACE, Environmental Coordination, National Environmental Policy Act (NEPA)

Daniel Hughes, USACE, Cultural Resources, National Historic Preservation Act (NHPA)

Katherine Rivers, USACE, Real Estate

Barbara Nist, USACE, Geology

Sheldon Shuff, USACE, Office of Counsel

Jason Harrah, USACE, Project Management

### 10.2 Reviewers

#### Agency Technical Review Team

Byron Rupp, USACE, Plan Formulation

John Winkelman, USACE, Coastal Engineering

Edmund O'Leary, USACE, Economics

Patricia Bolton, USACE, Cost Engineering

Jim Neubauer, USACE, Cost Engineering

Catherine Rogers, USACE, Environmental Coordination, National Environmental Policy Act (NEPA)

Belinda Estabrook, USACE, Real Estate

George Claflin, USACE, Geotechnical Engineering

# CHAPTER 11

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